EDITORIAL

AT last Los Angeles is the largest city in the world. Some fifty square miles of territory was added on June 6 to the already large area, the ground lying between the city proper and the Pacific Ocean at Santa Monica.

IN another column we print a communication relative to the flood-control legislation now pending before Congress. We are not prepared to speak concerning the Mississippi River plans, but our correspondent is clearly in error regarding the Sacramento River project. Landowners are to pay the actual cost of reclamation, the Federal government paying only for much-needed improvements to navigation conditions.

CONTROL of the Union Oil Company of California has been vested for many years with the so-called Stewart interests, through the medium of two holding companies, the United Petroleum and Union Provident. Now it has passed into the hands of a voting trust, a majority of the stock having been placed in the hands of nine trustees for a period of seven years. The Union Provident Company is to be dissolved, while the United Petroleum Company, which owns other property in addition to the Union stock, will continue in business.

BOND-ISSUES for both excellent and doubtful projects felt the heavy hand of popular disapproval at Los Angeles last month. The chief of these was a proposed issue of $8,000,000 for the construction of a municipal telephone system. Perhaps the inherent foolishness of this fantastic scheme was so apparent as to carry with it in defeat the other smaller issues, many of which possessed genuine merit. Among these were those for sewer extensions and disposal plants, $1,800,000; fire houses and apparatus, $1,250,000; and for the Second-Street tunnel, $300,000. Efforts are now being made to construct at least the sewage disposal works through the diversion of funds from the current tax-levy. A new city charter was also defeated, largely because it was feared that it might afford increased opportunities for the expenditure of public funds.

PLATTSBURG, New York, is associated in the public mind with preparedness. Unfortunately, such preparedness as may exist at that locality is imported, rather than indigenous to the soil. Some time ago, the City Council, in a spasm of alleged economy, decided to dispense with the services of a city engineer. The city authorized the construction of a dam, which, by reason of a further extension of the policy of economy was far from water-tight. When the dam was placed in commission signs of weakness unmistakable to an engineer became manifest; but they were ignored by the non-technical city officials in charge. So the dam failed. Now the tax-payers of Plattsburg have had a real lesson in economy, through the destruction of property valued at an amount that would have paid for the employment of a competent city engineer for many years to come.

THE California State Highway Commission has brought out another issue of the 'State Highway Bulletin,' which in appearance and subject matter is even more interesting than its predecessors. The question of overhead expense is briefly discussed. This item of cost in State highway construction has been criticized by a number of people, and it is hoped that the answer made by the Commission will set this matter finally at rest. A large map of the State is included, upon which are shown highways already constructed from funds provided by the original bond issue of $18,000,000 and in addition those that will be constructed if the proposed additional issue of $15,000,000 is authorized. In view of the approaching election, the greater part of the text is devoted to demonstrating to the general public that the State highway funds are being wisely expended rather than to subject matter of special interest to engineers and contractors.

GOOD-ROAD construction by California counties is making progress. The Fresno County Highway Commission proposes to build a system comprising approximately 441 miles. The principal highways are to be paved with concrete with an asphaltic surface, those subject to a lesser amount of traffic are to be graveled, and the greater part of the work on mountain roads is to be confined to the elimination or reduction of grades and curvature. The estimated total cost of this work is $3,500,000. Sacramento county also proposes to construct a system comprising 124 miles at a cost of $1,750,000. All of these roads will have a concrete base, with the exception of a few miles of graveled road. It will be remembered that about two years ago a highway bond-issue in this county was defeated, principally because doubt was expressed as to whether or not the proposed system could be constructed within the amount of the bond issue. The present plan includes a smaller mileage and the bond issue is also smaller, but, however, it appears to be ample for the completion of the work.

THE United States Bureau of Mines has issued a statement of the cost of producing gasoline by the Rittman process. Necessarily, the figures given are based upon small-scale experiments, since, thus far, no plant using this process is operating on anything like a com-

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mercial scale. It is also true that the figures are based upon Eastern crude, so their application to California oils is more or less conjectural. Nevertheless, a fair idea is conveyed as to whether the adoption of the process may reasonably be expected to result in an appreciable reduction in the cost of gasoline. It is estimated that with crude oil at $0.50 per barrel, the cost of producing gasoline will be $0.078 per gallon. Based upon crude oil at $2.10 per barrel, gasoline would cost $0.139 per gallon. This, of course, is the actual manufacturing cost to the refiner, and omits administrative and selling expense, and all overhead charges outside of those distributed to the manufacturing department. It is not so long ago that gasoline was selling retail to motorists in San Francisco for 11 cents per gallon. The figures given above would not indicate that a return to this price is imminent. Assuming that the Rittman process will prove a success, commercially, it seems probable that its greatest benefit will be derived from an increased extraction of gasoline per barrel of oil rather than a marked decrease in the cost of gasoline itself.

ONCE again the question of unrestricted competition *v.* monopoly subject to regulation is before us. The saving clause in the course of action pursued by the Railroad Commission of California lies in its power to refuse to grant a certificate of public necessity and convenience to any competing enterprise, if the existing utility is giving satisfactory service. A decision was rendered by the Commission a short time ago in the case of the Midland Counties Public Service Corporation *v.* Santa Maria Gas & Power Company. The Midland Corporation has been supplying gas to San Luis Obispo for several years. Complaint has been made regarding the service, some of which the corporation has admitted was well-founded. The corporation also made the usual statement that efforts were being made to remove the cause for the complaints. The Santa Maria Gas & Power Company, which, we understand, has been giving satisfactory service to several towns near San Luis Obispo, applied to the Commission for permission to extend its mains to serve that city, and the application has been granted over the protest of the Midland Corporation. The question as to what does or does not constitute satisfactory service is difficult to determine. Most consumers complain the greater part of the time concerning any service that they may get. In fact, kicking, if it may be so-called, is more or less chronic in any community. It is difficult indeed for the Commission to know just where to draw the line between the complaints that are well-founded and those that are not. The Commission was severely criticized by many for withholding from the Oro Electric Corporation permission to enter the city of Stockton and compete with the Western States Company. A public service corporation, denied the right to enter territory already served by an existing company, has the privilege of appealing to the courts. Whether this rule works both ways, or, in other words, whether an existing utility can appeal against the decision of the Commission after the latter has granted a certificate to a competing corporation, is an interesting legal point that we would like to have decided.

MUNICIPAL competition with private enterprise seems to be extending itself rapidly in the contracting field. The city of Aberdeen, Washington, is preparing to undertake the construction of a water-system. Bids were opened from several reputable contractors early in June. As is usually demanded, the low bidder and several of the other bidders had agreed to employ local labor as far as possible. Nevertheless, the city council rejected all bids and decided to construct the system by day-labor. We do not know whether this decision was followed by a banquet given by the local chamber of commerce or whether the tax-payers of Aberdeen are looking far enough ahead to wonder how much of the city's money will be saved by this course. It is undoubtedly true that in some cases an energetic, capable city engineer can handle such work as street-paving as economically as a private contractor. Such equipment as is required can be purchased and then used over and over again, so that the cost can be distributed over a period of years and not be charged against any one job. This statement, of course, is predicated upon the employment of a thoroughly competent city engineer who is not hampered by political considerations. For the job in question, however, a great deal of expensive equipment must be purchased in order to handle the job economically. After the work is completed, the city will have to sell at a sacrifice or else try to derive some revenue from it by renting. Since the equipment is of such nature that it is improbable that the city will find further use for it, its cost will have to be absorbed by the one job in hand. We must protest against the obvious unfairness of the officials of Aberdeen in pursuing this course. A number of contractors spent a great deal of time and money in going over the ground before they were able to prepare their bids. If the city intended to carry on the work by day-labor, the figures that they got from the bidders were obtained under false pretenses. So far as we know, there was no evidence whatever to indicate collusion among the contractors, in fact the lowest bid was well below the engineer's estimate, and even apart from the moral aspects of the case we do not believe that the course pursued by the officials of Aberdeen will pay them in the long run. Contractors, knowing what happened in this case, will think twice before expending time or money in preparing bids on any more work for the city of Aberdeen. Any reputable bidder is glad of an opportunity to go against fair and open competition, but he does like to know beforehand whether or not bids are called in good faith. Had the lowest bid been higher than the engineer's estimate, the city officials would have been justified in throwing out all bids. As it is, the least they could have done would have been to reimburse the lowest bidder for his expense in preparing his estimate. We do not see why a city should not be fair.

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REVIEW OF THE MONTH

RAILROADS have been built both by private enterprise and municipalities. Now we are about to welcome a new idea, a hyphenate in the field of engineering, the construction of a railroad through the joint effort of private enterprise and municipalities. Two Oregon cities are to try the experiment, Roseburg and Medford. There is a large area of timber and agricultural land about twenty miles from Roseburg, which has been awaiting development for a long time. Lack of transportation facilities stood in the way, until a plan was devised whereby an Eastern lumber company and the city agreed to undertake the joint construction of a railway 24 miles long to tap the undeveloped area. The lumber company is to construct a saw-mill at the terminus. As was to have been expected, a number of legal difficulties delayed the city in raising funds for its share of the cost, but now they have been removed and the contract for constructing the railroad will be awarded soon.

MEDFORD is the other city which is preparing to embark upon the stormy sea of railroad building. The railroad in this instance is to be built through a mining and agricultural district to the Blue Ledge mine, near the California-Oregon State-line. The city is to lend its financial aid to a company which is unequal to the task single-handed. Although, in this case, negotiations have not progressed as far as in the Roseburg project, there seems to be no reasonable doubt that construction will be undertaken in the near future.

IN the administration of any of the numerous public-utility laws, the line of demarcation has thus far been sharply drawn between producer and consumer; corporation and the rate payers. Now we have before us a hyphenated sort of an arrangement whereby any decision affecting rates, valuations, and whatnot will hit government, private individuals and corporations regardless of the way they go. Here is an opportunity for a "Daniel come to judgment" indeed. The jointly-owned railroad will become a public utility, of course, and its rates subject to regulation in the latest up-to-date fashion. The citizen asking for reductions will understand that, should he accomplish his object, his tax rate will be increased in order to compensate for the loss in revenue brought about thereby. Of course, the thought that the burden is borne partly by the private ownership, will but incompletely salve his financial wounds. At any rate, the whole scheme is replete with possibilities for many interesting situations, and we will watch the experiment with great interest.

OF course, governmental assistance for enterprises of public benefit is not new. This was the regular thing in the 'good' old days of the 'Big Four' and the Central Pacific. The practice of donating enormous grants of public land, and guaranteeing odds and ends of bond issues became unpopular as the years went on. Promoters who "followed the grass roots for grade, and the county bonuses for alignment" are obsolete nowadays, and the man who attempts to promote a public utility must go to the general public for support. While it is not so long ago that money for any recognized railroad enterprise was comparatively easy to obtain, regulation now has such a strangle hold on the revenue-producing department, that ordinarily popular securities go begging, while municipal issues, in consequence, are the people's choice.

WHOSE fault is it? Most of us know, or at least have a fairly well conceived opinion. There is nothing to be gained by reviewing the stories of railroad promotion and stock juggling, from the Central Pacific of fifty years ago to the New York, New Haven & Hartford fiasco, whereby a fresh set of lambs was ready for the shearing, as fast as the last lot was denuded of its wool. The inevitable reaction set in, and veered sharply to the other extreme at first, and now, let us hope, is in a fair way toward the attainment of a sane, middle course of justice to both sides. Until the investing public can feel a reasonable surety that the public utilities will not be regulated off the face of the earth, they will not dig into their pocket-books for either extensions or new enterprises. One of these fine days, questions of internal economics will no longer be the football of partisan politics, and, until that time, we, the patients, will have to be content with 'resting easily' after the operation that has been performed by the surgeons of radicalism.

CALIFORNIA oil production is responding to the stimulus of higher prices. The figures for May show a daily average production of 249,000 barrels as against 246,000 barrels in April. For more than a year, the daily average has been in the neighborhood of 250,000 barrels except when the output was affected by unusual conditions, such as the heavy storms of last winter. Shipments continue to exceed production, about 1,000,000 barrels having been drawn from stocks in May. The 'shut-in' production is small, almost negligible as affecting the general situation. While the number of wells drilling is increasing steadily, there is no immediate prospect of production overtaking consumption. A further increase in the price of crude and refined products is probable.

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STATE control of storage dams has been strongly endorsed in the annual report of the California State Reclamation Board. The wisdom of this course, should a law be enacted accordingly, will depend upon the skill and experience of the State engineers. There is no doubt that some irresponsible dam-designing and construction has been done, as the people of San Diego have learned to their cost, and the public should be protected from a repetition of the disasters of last winter. It is to be expected, however, that the tendency of a board of examining engineers called upon to pass on dam designs would be toward a perpetuation of the old rather than any adoption of the new, taking the path of conservatism, or least resistance in accepting plans and specifications. Progress should not be stifled by conservatism. It is a difficult problem to solve, at best.

ANOTHER feature of the Reclamation Board Report is the emphatic condemnation of the idea that the Sacramento-River flood-control problem can be solved by the construction of storage reservoirs in the mountains, or that flood conditions can be ameliorated even, to any great extent, in this way. It is, of course, granted that storage reservoirs are a necessary part of most irrigation or power projects, and that frequently they are of value in retarding the crest of a flood. In many cases, however, the heaviest run-off takes place after the reservoir has been filled to overflowing. Thus the reservoir may even increase the flood peak. The hope of both the Sacramento and San Joaquin valleys for relief from the annual floods lies rather in the early completion of the plan agreed upon by the State Reclamation Board and the United States Army Engineers for channel improvements, levee construction, and by-passes to divert the excess water.

TWO years ago the jitney was unknown, a year ago it was a joke, today it is a problem. This is especially true in California, where the millions that have been expended on good-road construction have provided rights-of-way and perfect roadbeds without cost to the jitney operator. Even municipal jitneys, the *bete noir* of the privately-owned companies, have become more or less of a side issue as a thorn in the side of the capitalist. The interurban bus, a comparatively new factor in the field of motor transportation, is in a fair way to perform a capital operation upon the earnings of the suburban steam and electric rail lines. Experts in the calculation of operating-costs are still unable to see how 5-cent fares can return a profit to the jitney operator. This is a question that time alone will answer, but there seems to be no doubt that motor-buses operating over State highways or other improved roads are an economic success, provided that competition among their own kind does not ultimately make them self-destructive. As fast as a new section of State highway is completed, it becomes infested with bus-lines. Interurban electric railroads find their revenue diminished in direct ratio to the amount of bus competition. Steam lines also have suffered severely. The Colusa & Lake railroad has given up the ghost and the remains are soon to be sold for the benefit of the creditors. The Yreka railroad, we understand, is in little better condition. In fact bus-competition is becoming so severe that it is actually commencing to affect through-traffic. Several stages are now in operation between San Francisco and Los Angeles, charging lower fares than the rail lines. While the schedule is too slow for the business traveler, the ride itself is attractive to those who are on pleasure bent and have the time to spare. Freight traffic also is commencing to show signs of being diverted to the motor truck. The latter's greater flexibility offers a decided advantage on short hauls for both express and package-freight. In every department of the business, established transportation companies are losing revenue by reason of automobile competition.

HERE, then, is a condition, not a theory; and what is to be done about it? We do not believe that anyone would state seriously that railroads are to be superseded by motor vehicles, nevertheless, there is no denying the fact that business of any kind, whether it be passenger or freight transportation or any other kind of business, will follow the lines of least resistance, such lines in this case being the best service for the least money. Nevertheless, in attempting to meet automobile competition, the railroads and the street-car lines are suffering from certain handicaps which are man-made rather than due to natural conditions. In the case of the rail lines, franchises must be obtained, rights-of-way must be purchased and prepared, enormously expensive road-beds must be constructed, and so on, to the end that an investment of hundreds of thousands of dollars per mile is often necessary before the rail line commences to earn a dollar. As soon as the dollar is earned, the tax-gatherer and the Railroad Commission take a nibble at it so that it soon looks like 30 cents. The jitney operator conducts his business almost without restraint. He can, if he wishes, buy his 'Ford' on the installment plan, $100 down and $50 a month. He is now paying 19 cents per gallon for gasoline and can count reasonably upon 18 or 20 miles per gallon, even for city traffic. He operates over a road-bed that he does not own, and for the construction of which he has contributed little, if anything. He takes out a license at comparatively small cost, and is subject to no more regulation than that by the police traffic squad. In California the railroads pay 5¼% of their gross receipts in taxes to the State. The various attempts that have been made to impose a more nearly reasonable tax upon jitney operators were followed by the organization of a union that has presented such an imposing array of votes as to threaten the political life of the legislator who opposed their wishes. Why not give the railroads a square deal, determine the basis upon which they are taxed, and impose the same rates upon the automobile or motor-bus that is operated for public transportation purposes, and, in addition impose a road-tariff upon the same machines?

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DISCUSSION

A Volunteer Engineer Corps

The Editor:

Sir—Following our conversation over the telephone, you will be interested in knowing that after a conference with Capt. Park, Col. Perkins, Col. Swift, and the Adjutant-General's office of the State of California, I have decided to recruit a battalion of engineers for use in the present emergency. I intend recruiting this battalion from all portions of the State, one company headquarters to be located in San Francisco, another in Oakland or Berkeley, and a third at Los Angeles.

There are no volunteer engineer troops west of Golden, Colorado, and not nearly enough to supplement such troops as are at present mobilized, so that it is quite certain when this battalion is recruited to its full strength, that it will see service. I am taking the necessary steps to have engineers added to the California quota, as these troops will be certainly needed to properly take care of the castrametation of the present mobilization. Provisional headquarters are at the office of the Pelton Water Wheel Co., where I can be reached at any time.

As this battalion is the first of the engineers, outside the National Guard, to offer its services to the War Department, the probability of its being accepted is very high. The San Francisco company will be organized tonight, the Trans-Bay company will be organized tomorrow night, and the Los Angeles company within the next two or three days. Persons in the South desiring information regarding the Company can secure it from Charles T. Leeds, Central Bdg., Los Angeles.

I trust that you will be able to find space for this in your columns.

J. W. Swaren.

San Francisco, June 19.

The Engineers' Division in the San Francisco Preparedness Parade

The Editor:

Sir—Plans are now under way for an engineers' division in the Preparedness Parade in San Francisco on July 22, in which it is hoped that all engineers, whether members of the national engineering societies or not, will march if they can possibly arrange to do so.

The executive committee in charge of arrangements is composed of J. D. Galloway, chairman, E. B. Bumsted, Guy L. Bayley, E. M. Boggs, W. W. Briggs, J. Q. Barlow, W. A. Cattell, A. E. Chandler, W. J. Davis, Geo. W. Dickie, W. A. Doble, W. R. Eckhart, A. H. Griswold, C. E. Grunsky, C. M. Gunn, H. L. Haehl, H. H. Hall, A. A. Hanks, Charles G. Hyde, Carl Heise, Wm. Hood, Charles Janin, B. P. Legaré, C. W. Merrill, R. S. Milne, Thomas Mirk, Thomas Morrin, Jerome Newman, Edmund O'Neill, M. M. O'Shaughnessey, W. H. Shockley, T. J. Wyche, F. L. Webster, and C. B. Wing.

The recruiting committee is composed of Guy L. Bayley, chairman, A. E. Chandler, C. C. Brayton, C. F. Braun, B. S. Drake, A. A. Hanks, A. G. Jones, and E. T. Thurston.

The parade committee is composed of Geo. L. Dillman, chairman, J. R. Brownell, H. W. Crozier, R. H. Elliott, W. C. Hammatt, H. F. Jackson, Geo. R. Murphy, E. J. Schneider, and W. Vincent.

The finance committee is composed of E. B. Bumsted, chairman, A. H. Griswold, and F. W. Gay.

The music committee is composed of E. H. Frisell, chairman, W. A. Cattell, and C. H. Snyder.

B. P. Legaré.

San Francisco, June 27.

The Choice of a Water-Wheel for Electric Generator Drive

The Editor:

Sir—It is axiomatic that the higher the speed of the electric generator, the lower the first cost; while in the case of a water-wheel the reverse is usually true. In the majority of cases the lower-speed water-wheels are less in first cost by reason of certain inherent structural difficulties. Obviously, the best practice is to plot curves of generator cost and water-wheel cost against revolutions per minute. This can be done by securing tentative prices from water-wheel manufacturers, and it will be noted that the prices submitted by different manufacturers are apt to vary by reason of the differences in shop organization. The three governing factors, namely, normal horse-power rating, operating head, and speed are combined in a single characteristic known as 'specific speed.'

The formula for securing specific speed is:

$$n_s = \frac{N\sqrt{HP}}{h^{5/4}}$$

Where n_s = specific speed
N = R.P.M.
h = net operating head
HP = the power.

This is a rather difficult formula to solve, and had best be expanded to the formula:

$$n_s = \frac{N}{h}\sqrt{\frac{HP}{h^{1/2}}}$$

Since the number of revolutions per minute for the generator is fixed by the necessary synchronous speeds, the next step in the selection of the water-wheel is de-

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termining the desired generator speed, the desired horsepower, the known head, and to solve the equation for n_s, which is the symbol for specific speed. If the specific speed thus determined is less than 10, a tangential wheel is indicated. If, on the other hand, the specific speed is greater than 90, it is not practical in the present state of the art of turbine design to build a turbine meeting the required conditions. These, of course, are generalizations, but will be found to meet the great majority of cases.

Although tangential units have been built with specific speed as high as 25, it requires a multiplicity of runners with the accompanying nozzles. Therefore, this speed can be obtained only with accompanying operating difficulties that would not be present for a turbine of similar speed and power characteristics. Single-runner single-nozzle tangential units have been built for a specific speed of 10, but the best operating range is lower than this. In fact, for structural reasons, it is desirable to hold specific speed of a single runner and single nozzle at a point below 5. If the solution of the specific-speed formula indicates a specific speed in excess of 5 or 6, but lower than 10, and it is also desired to keep the cost of the unit as low as possible, choice must be made between a double runner and a double nozzle.

Another element to be taken into consideration is that of 'flywheel' effect, commonly expressed as WR^2, where W is the weight and R is the radius. This depends largely upon the dynamic characteristics of the pipeline which are an element to be taken into consideration by the water-wheel manufacturer. While with the tangential type of hydraulic prime-mover, flywheel effect is provided in the weight of the runner, with turbines, auxiliary flywheels mounted direct upon the turbine-shaft are frequently required. The accurate calculation of this characteristic, influences to a large degree the speed regulation of the combined unit.

J. W. Swaren.

San Francisco, June 3.

The Mississippi Flood-Control Bill

The Editor:

Sir—On May 17 a so-called Flood-Control Bill passed the House carrying $45,000,000 for the lower Mississippi river and $5,600,000 for the Sacramento river, or $51,600,000 in all. A strong propaganda managed by a well financed lobby having hundreds of millions at stake, operating through the Mississippi River Levee Association, has appealed to public sympathy and hypnotized State legislatures and national conventions with the cry of national responsibility for Mississippi floods, whereas these steadily increasing floods are directly attributed, by well informed people, to the dangerous lower river levee system.

Behind political levee boards, a gigantic private land reclamation scheme reaching 16,000,000 acres is discussed in the Committee report—all under the attractive slogan of 'flood control.' Local interests are required under the House bill to contribute only $15,000,000 toward reclaiming this 16,000,000 acres of flooded land which eventually is to be worth between one and two billion dollars.*

Major West of the Mississippi River Commission has testified it will cost the Government $228,000,000 to levee and revet the river banks.† The Army engineers propose to harness a river which naturally overflowed 16,000,000 acres of land and was 60 or 70 miles wide and 70 feet deep in the channel at Vicksburg during flood time and confine the flood waters between levees to be built and protected by the Government at an expense of over $200,000,000, in order to reclaim this 16,000,000 acres of private land. At this time of treasury deficit, with great pending emergency expenditures and increased war taxes laid upon our people, what can be offered to justify a $42,000,000 wasteful river and harbor bill and a $51,600,000 private land reclamation bill, both of which are now pending?

James A. Frear.

Washington, D. C., May 24.

PROPOSED WATER DISTRICT FOR SAN FRANCISCO BAY CITIES

Plans for solving the water-supply problems of the cities in the vicinity of San Francisco bay were discussed at a recent meeting of the Commonwealth Club of California. Addresses were delivered by C. E. Grunsky, J. D. Galloway, and H. D. Dewell. The plan proposed provides for the formation of a water district organized on lines similar to the Metropolitan Water District that supplies Boston and a number of neighboring cities and towns. This district would contain 20 municipalities in all, reaching from San Francisco to Mountain View on the western side of the bay and from Richmond to Hayward on the eastern side. The estimated population of the cities included in the district is 908,000, and the total area, 219 square miles.

It would be necessary that the legislature should pass a special enabling act creating the district. The question of joining the district would then be left for each municipality to decide for itself. The district, however, would not be definitely formed unless San Francisco together with several other towns should decide favorably. This would be in order to insure sufficient resources for the district. The affairs of the district would be administered by a water board of three members appointed by the Governor. The district would be empowered to acquire water supplies and to sell water wholesale to the municipalities, the latter to retail the water, handling their own distributing systems. A committee appointed by the Club is now engaged in drafting a law embodying substantially the above provisions, and it will be presented at the next session of the legislature.

*Congressional Record, page 8636.
†Congressional Record, page 8637.

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California's Longest Concrete-Arch Bridge

By THOMAS A. BEDFORD*

The Pit River bridge, on the State highway, the longest concrete-arch bridge in California, and lacking but a few feet of being the longest concrete arch west of the Rockies, has recently been completed. The bridge is in Shasta county near Baird, a short distance below the junction of two mountain rivers, the Pit and the McCloud.

The bridge site is picturesque, with a background of rugged peaks covered with pine and fir, and the clear, deep river. Advantage was taken of this beautiful setting by making the bridge of one long arch-span over the river, with a large pier at each end and a girder span leading from each pier to an abutment connecting with the highway. The clear arch-span is 242 ft. and the girder-spans about 37 ft. each. The bridge floor is supported over the arch-span by columns and girders, and is 65 ft. above the normal stage of the river and 35 ft. above maximum high water. The roadway of the bridge is 21 ft. wide.

The estimated quantities of the principal materials were as follows:

Concrete, 1: 2: 4 mixture	1,010 cu. yd.
Concrete, 1:2½:5 mixture	978 cu. yd.
Reinforcing steel	184,000 lb.
Rock excavation	400 cu. yd.

The State furnished the cement and the reinforcing steel. The contract price for furnishing all other materials and constructing the bridge was $28,235. The materials furnished by the State cost $10,002, making the total cost of the bridge, $38,237.

The bridge was designed by the engineering department of the California Highway Commission, under the direction of A. B. Fletcher, highway engineer. It was erected by the Ross Construction Co., of Sacramento, California.

On account of the swift current, and the depth of the stream, it was not thought advisable to place falsework in the water to support the forms for the concreting of the arch-ribs. The arch-ribs are two in number and are braced together by diagonal concrete members reinforced heavily with steel rods. The arch-ribs were also reinforced with steel rods, as was the floor system and columns.

The contractor proposed to span the swift portion of the river by a wooden Howe truss. He submitted his design to the engineering department of the California Highway Commission, by whom it was checked and approved. On top of the truss, ordinary posts and bracing were erected to carry the forms, the same system being used for the remainder of the falsework. The timbers for the falsework were mostly round logs, which were cut in the woods one-half mile up-stream. A small donkey-engine pulled them into the river and they were floated to the work accompanied by men in a rowboat. It was perilous work for the men in the boat. Frequently the logs got beyond their control and were carried down the river.

The great problem in erecting the falsework was in getting the Howe truss across the river. This was accomplished by erecting some temporary bents at one end and placing the bottom members of the truss on them, allowing the members to project into the stream to the middle of the truss span. Some wooden piers had been constructed previously to support the truss

*Division engineer, California State Highway Commission, Dunsmuir, California.

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span and the falsework joining the truss span was also erected. A donkey-engine hoist was used to erect the falsework, advancing as the work proceeded to a point directly over one end of the truss span. By means of a cable and blocks from a high point on the opposite side of the river and the cable from the boom of the donkey-engine hoist, the remaining half of the bottom members of the truss were lifted out of the river log by log and placed on the wooden pier and the projecting half of the bottom members. The logs were then cut to proper lengths and lowered to the level of the projecting half of the bottom members. A substantial splice was made by bolting and doweling dimension timbers alongside and between the logs composing the bottom members. The bottom members were then trussed by means of cables passing under temporary posts, thus making a rigid girder upon which the diagonal members of the truss were erected and later the top members of the truss. The steel tie rods were then placed, the temporary bents and cables removed and the truss span was complete. It was a simple matter to erect the remainder of the falsework and forms; however, it takes men of steady nerves to work in such airy places.

CRUSHED BRICK AND OTHER UNUSUAL MATERIALS FOR CONCRETE-AGGREGATES

Experience in the use of several unusual materials for concrete-aggregates is summarized by Carl H. Fuller in *Concrete*.

Crushed vitrified paving block, when not contaminated with paving-pitch or asphaltic fillers, makes a good, sound concrete having a strength closely approximating that made from the finest granite. It should not be used for patching or adjacent to rock concrete since it has a darker and more distinctive color. When crushed to ¾ in. and under, it gives satisfactory results in thin reinforced work and floors. Crushed sewer-tiling being practically the same material gives nearly as good results, the slight glaze having apparently no bad effects.

Crushed building-brick, usually being of a softer nature, does not produce quite as strong concrete, but is an acceptable substitute in foundations for paving operations, or walls where mass rather than strength is desired. Unless all of the brick are hard-burned, considerable care should be exercised in using them for any other kind of concrete.

Re-crushed concrete makes a good aggregate for mass work or paving operations but unless the original concrete was of exceptionally good quality its use should be avoided where strength is desired, as it is usually much inferior to fresh stone.

All of the materials should be cleaned thoroughly before crushing. The dust being screened out after crushing. If possible, the materials should be washed with clean water as the crushing operation produces a large proportion of fine dust that is detrimental to making good concrete. Building brick that has been laid in sand-lime mortar should have the mortar removed carefully before crushing. Sometimes the crushing and screening will do this work effectively. Paving-block that has been laid with cement grout does not need to be cleaned, as the crushing and screening will remove the loose cement.

Paving-block that has been laid with pitch or asphalt fillers should be cleaned carefully before crushing. This is imperative as the cement will not adhere to particles of pitch, or pitchy surfaces. If such brick must be used they can be cleaned by racking in kiln formation and building a wood fire under them until they are burned clean. Coal should not be used for this purpose as it leaves a greasy deposit on the faces of the brick. Brick may also be cleaned by hand during cold weather, but results are generally unsatisfactory.

All such material should be wet thoroughly before using. The best way is first to charge the empty mixer with the water, then add part of the cement, the crushed brick, sand, and the remainder of the cement in order. By so doing the porous material will become saturated with the cement, adding considerable strength to the final product. This method of charging also has the merit of leaving the mixer clean at all times.

Concrete made with brick aggregate should be rich in cement as the porous nature of the aggregate absorbs more of the finer particles than ordinary stone. However, when the concrete has been handled as described, test pieces will almost invariably break through the brick, showing that the concrete is of equal or greater strength than the aggregate used. Soft-burned or adobe brick should never be used, as such material has a low tensile strength and some of it crumbles readily to dust.

FINAL REPORT ON CONSTRUCTION OF LOS ANGELES AQUEDUCT

The Department of Public Service of the city of Los Angeles is shortly to issue a final and complete report on the construction of the aqueduct. By careful revision and editing it has been possible to bring the size of this report down to a single volume of 350 pages, 8½ by 11 in., with 88 half-tone illustrations and 45 line drawings. At it is impossible to distribute the report without charge, a price of $1.95, postpaid, has been set upon it. Orders should be addressed to the Department of Public Service, 645 South Olive street, Los Angeles. Not more than one copy will be sent to any individual. The report will probably be ready in September.

The use of a concrete-mixer as a road-roller at Glenwood, Iowa, is described in *The Cement Era*. The mixer was a No. 15 Chain Belt paver. Auxiliary wheels with ½-in. steel tires, 30 in. diam. and 24-in. wide, were slipped over the regular wheels. The outer half of each tire was loaded with cement and sand to give it additional weight. The pavement subgrade was well compressed in this way and the cost of fitting up the mixer, about $75, was considerably less than that of shipping a regular roller to the work.

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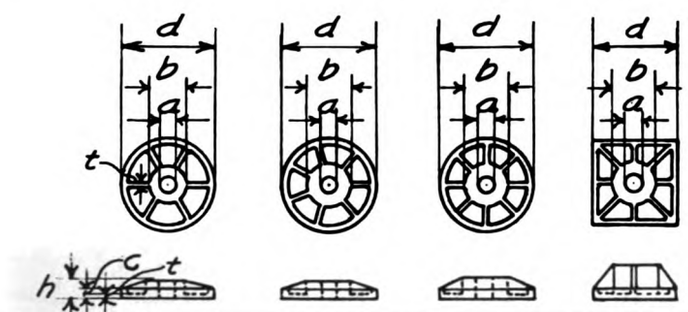
Timber Framing—Part II

By HENRY D. DEWELL*

WASHERS

Compression on Surfaces Inclined to the Direction of Fibres. Resistance of Timber to Pressure from Cylindrical Metal Pins. The comparative weakness of soft timbers like Douglas fir to compression across the fibres has been mentioned, likewise the prevailing use of the standard cast-iron and malleable-iron washers with bolts and rods. This practice is altogether too common, and results mainly from an unwarranted and ignorant confidence on the part of the designer and constructor in the word 'standard.' Standard details in steel construction are usually the result of careful and intelligent study, and long experience, but even standard details in steel will not be suitable for every case. In timber construction the term 'standard' means even less, and many details to which this term is applied are unfit for even the average case.



Size Bolt	Size Upset	a	b	c	d	h	t	Shape Base	No. Ribs.	Wgt.
5/8	Not U	3/4	1 9/16	1/8	3 1/8	3/4	1/8	C	6	.56
3/4	"	7/8	1 3/4	3/16	4	1	1/4	C	6	1.10
7/8	"	1	2 1/4	3/16	4 1/2	1 1/8	1/4	C	6	1.80
3/4	1	1 1/8	2 3/8	1/4	5 1/4	1 1/4	1/4	C	6	2.79
13/16	1 1/8	1 1/4	2 5/8	1/4	5 5/8	1 5/16	1/4	C	6	3.29
7/8	1 1/4	1 3/8	3	5/16	6 1/2	1 7/16	5/16	C	7	5.30
1	1 3/8	1 1/2	3 1/4	5/16	7	1 9/16	5/16	C	7	6.34
1 1/8	1 1/2	1 5/8	3 1/2	3/8	7 7/8	1 11/16	3/8	C	7	9.04
1 1/4	1 5/8	1 3/4	3 3/4	3/8	8 5/8	1 15/16	3/8	C	7	11.30
1 3/8	1 3/4	1 7/8	4	3/8	9 1/8	2 1/4	3/8	C	7	13.59
1 7/16	1 7/8	2	4 3/8	7/16	10	2 3/8	7/16	C	8	18.66
1 1/2	2	2 1/8	4 5/8	7/16	10 3/16	2 7/16	7/16	C	8	20.39
1 5/8	2 1/8	2 1/4	4 3/4	1/2	11 1/4	2 5/8	1/2	C	8	25.99
1 3/4	2 1/4	2 3/8	5 1/8	1/2	12 1/8	2 3/4	1/2	C	8	30.62
1 7/8	2 3/8	2 1/2	5 1/8	5/8	11 1/4	4 1/4	5/8	Sq.	8	48.23
2	2 1/2	2 5/8	5 5/8	3/4	12	5 1/8	3/4	Sq.	8	69.32

FIG. 1. DIMENSIONS OF SPECIAL CAST-IRON WASHERS.

If the use of the standard O. G. cast-iron washer and the standard malleable-iron washer is to be condemned, what may be said of the employment of small circular pressed-steel washers with timber of low cross-bearing strength? These latter washers were originally designed for use with hard woods, yet they are constantly employed in ordinary construction, with the result that the washers are usually found to be drawn far into the wood, and the resistance to further tension in the bolt is nil.

It is not intended to make the assertion that all bolts require large washers to fulfill their function properly. Relatively short bolts acting in shear, as in splice joints, may be designed with small washers with safety. All bolts and rods, however, which act in tension should be provided with washers of ample area, and even those joints in which the bolts act principally in shear will be greatly strengthened and their effective life increased by the use of washers of generous size. Except for temporary work, the employment of larger washers than the standard will always be economical, when all the factors are considered. Especially is this true where the timber work is exposed to the weather, as the tightening of the nuts on the bolts when washers of insufficient size have been used will crush the timber, exposing it to the weather with consequent decay.

F. L. Bixby made a series of tests on the efficiency of the standard O. G. cast-iron washer in the course of thesis work at the University of California in 1904. These tests have been reported by me.[1] Mr. Bixby found that the standard washer would develop from 30% to 45% only of the strength of the corresponding rod. Special O. G. washers were then designed with the following diameters.

¾-in. bolt, 4.38-in. diameter washer
⅝-in. bolt, 3.44-in. diameter washer
½-in. bolt, 2.96-in. diameter washer.

Tests were made on these washers as on the standard washers. The results, rated on one-half the stress required to strip the thread of the rod in tension, showed average efficiencies from 86% to 91% as against the low efficiencies noted above for the standard washers. A typical load-compression curve of Mr. Bixby's tests is shown in Fig. 2. The timber was Douglas fir in all cases.

The tests show conclusively that for all washers with tension rods pulling across the fibres of Douglas fir, the area of the washer should be such that the unit bearing-

*Consulting engineer, Holbrook Bdg., San Francisco, formerly Chief Structural Engineer, Panama-Pacific International Exposition.

[1] *Engineering News*, Vol. 71, No. 13.

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stress will be the same fraction of the elastic limit of the timber for cross-bearing as the unit stress in the rod is of the elastic limit of the rod in tension. By reference to Plate II of the preceding article, the average elastic limit of Douglas fir for compression across the fibres is seen to be 570 lb. per sq. in. Consequently, if the elastic limit of steel rods is assumed to be 32,000 lb. per sq. in., the corresponding unit working-stress for the washers should be 285 lb. per sq. in. This low stress may seem to be extravagant, inasmuch as many timber trusses of Douglas fir are giving service with much higher washer-pressures. It may be definitely stated, however, that in the event of a considerable overload, the washers would crush the timber of the truss chords to such an extent that excessive deflection with a probable consequent failure of the truss would occur, while the rods would not be dangerously overstressed. With such a truss, where the rods are designed for 16,000 lb. per sq. in., and the washers for a bearing pressure of 400 lb. per sq. in., the critical strength of the truss would not be

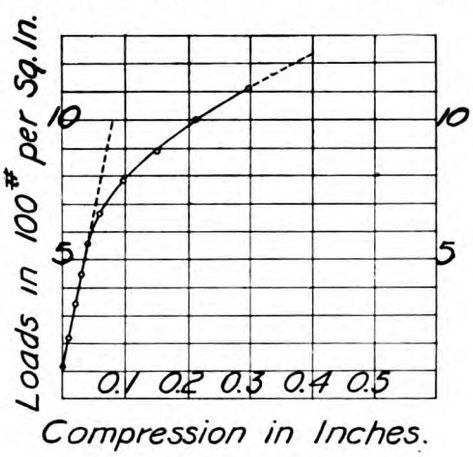

FIG. 2. TYPICAL WASHER CURVE.

lessened were the sizes of rods to be decreased until their unit stress became 22,400 lb. per sq. in. In other words, looking at the matter from simply the commercial standpoint, the engineer may increase the unit stress in the rods of a truss, and design the truss with smaller rods and larger washers than are ordinarily used, and still feel confident that the truss is as safe as one having conservative unit-stresses in the rods and high bearing-pressures under the washers.

In the framing of the Panama-Pacific International Exposition buildings, special ribbed cast-iron washers were designed and used. Their dimensions are shown in Fig. 1. These washers were designed for a bearing pressure on the timber of 350 lb. per sq. in. and a corresponding unit stress in the steel of 16,000 lb. per sq. in. In this case, the rather high unit-stress for cross-bearing on the timber was justified by the fact that all the work was of a temporary nature, and first cost, consistent with safety, was the governing factor in the design.

To check the strength of the washers as designed, some tests were made on the various sizes, at the University of California. The first washer tested was a $\frac{3}{4}$-in. washer. It was placed in the testing machine fitted with a short length of bolt and nut, the nut bearing against the head of the testing machine, and the washer bearing across the fibres of a short block of Douglas fir. The bolt fitted into a hole bored into the wood. Although a total load of 23,000 lb. was sustained without fracturing the washer, the latter sank into the timber $\frac{1}{2}$ in. under the pressure, and the test had to be discontinued without having reached the capacity of the washer in cross breaking-strength. The other washers were broken by making them bear against the ends of the fibres of the block of Douglas fir, the head of the testing machine resting directly upon the washer. The ends of the wooden block were not exactly parallel, so that the machine head bore eccentrically on the washer, producing bending stresses in the cast iron. As this condition often exists in actual construction, the bolts being not exactly normal to the timber, the results of the tests may be taken as typifying the strength of such washers under the most adverse conditions of construction.

Table I gives the results of the tests. The specimens tested were from two different foundries; in the table of results the two sets are designated as *A* and *B* washers.

TABLE I

FAILURE TESTS OF EXPOSITION WASHERS

Size	Ultimate Load-Lb.	Remarks
	Washers from Foundry *A*	
$\frac{3}{4}$	20,000	Failure at edge of head.
$\frac{3}{4}$	28,000	Failure through head.
$\frac{3}{4}$	16,000	Failure through ribs: flaws.
$\frac{3}{4}$	17,000	Failure through ribs: flaws.
$\frac{7}{8}$	33,000	Failure through head.
$\frac{7}{8}$	23,500	Failure at edge of head.
1	23,500	Failure through head.
	Washers from Foundry *B*	
$\frac{5}{8}$	18,000	Failure through ribs near rim.
$\frac{5}{8}$	20,500	Failure through ribs near rim.
$\frac{3}{4}$	7,500	Failure through centre of hole.
$\frac{3}{4}$	9,500	Failure through head.
$\frac{3}{4}$	9,500	Failure through head.
$\frac{7}{8}$	16,000	Failure at edge of head.
$\frac{7}{8}$	14,000	Failure at edge of head.
1	25,600	Failure through head.
1	17,000	Flaws.
1	23,000	Small flaws.
1	26,000	Small flaw.
1	23,000	Small flaw.

The dimensions of the washers tested were all as shown in Fig. 1, except that in the case of $\frac{3}{4}$-in. washers, h was $1\frac{3}{16}$-in. instead of 1 in. and t was $\frac{3}{16}$-in. instead of $\frac{1}{4}$. Similarly, for the $\frac{7}{8}$-in. washers, t was $\frac{3}{16}$-in. instead of $\frac{1}{4}$-in. Due to the rather poor showing of the *B* foundry washers, the dimensions of the $\frac{3}{4}$-in. and $\frac{7}{8}$-in. washers were increased as noted in the preceding paragraph and to the dimensions shown in Fig. 1. The effect of shrinkage and flaws is much greater in the smaller sizes of washers than in the larger sizes, consequently there should always be more metal than might be called for by strict observance of theoretical dimensions. Further, in driving bolts and tightening nuts, the washers are subject to considerable hammering, and for these reasons any thickness of metal less than $\frac{1}{4}$ in. is not advisable.

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In Jacoby's 'Structural Details,' there is published the result of a series of tests on cast-iron and malleable-iron washers by H. M. Spandau, which shows that ribbed cast-iron washers of equal strength with the O. G. type may be designed, and at a saving in metal of from 30 to 50%. There are also given details of ribbed cast-iron washers used as standard by the Atchison, Topeka & Santa Fe and the Union Pacific railroads. Further tests of cast iron washers were made by L. R. Rodenhiser in the course of thesis work at Cornell University.[2]

Compression on Surfaces Inclined to the Direction of Fibres. The preceding discussion relates only to washers bearing normally on and across the fibres of the timber. Where the direction of pressure is inclined to the direction of the fibres, the area for bearing need not be so large, and it will usually be found convenient and economical to use washers of special design, either of cast iron or of plate steel.

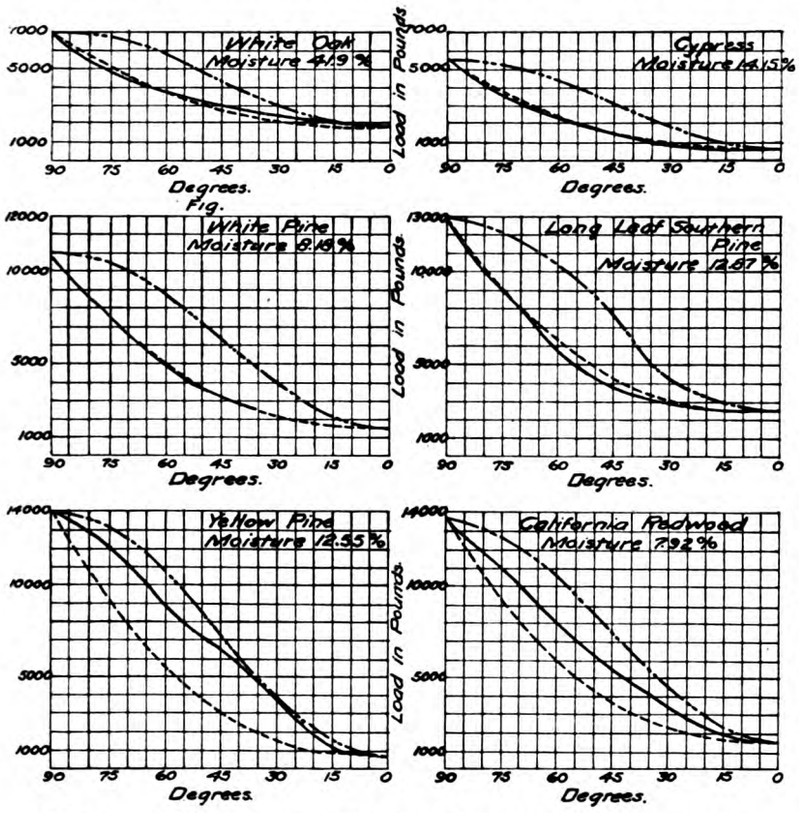

PLATE IV. BEARING VALUES FOR WOOD ON SURFACES INCLINED TO THE GRAIN AT VARIOUS ANGLES.

The resistance to compression offered by the fibres of the timber when the pressure is exerted at an inclination with the direction of the fibres, namely, neither normal nor parallel to the fibres, is a subject on which there is some difference of opinion. Prof. Jacoby, in his 'Structural Details' develops the following formula,

$$n = p \sin^2 \Theta + q \cos^2 \Theta$$

in which

n = the allowable unit stress on a surface which makes an angle Θ with the direction of fibres

p = the allowable unit stress against the ends of the the fibres

q = the allowable unit stress on the sides of the fibres

Fig. 3 shows this equation plotted, using the values $p = 1800$ lb. per sq. in., and $q = 285$ lb. per sq. in. These values are approximately one-half the values for the elastic limits as shown on Plate II.

Malverd A. Howe publishes[3] the results of some tests made to determine the allowable bearing pressure on inclined surfaces for various timbers. These results are shown in the diagrams of Plate IV, which are taken from the article just mentioned. Mr. Howe recommends the formula

$$n = q + (p - q) \left(\frac{\Theta^\circ}{90^\circ}\right)^{5/2}$$

which equation corresponds closely to the values as determined by the tests. Fig. 4 shows this formula plotted, using the values $p = 1800$ and $q = 285$, as before.

The allowable unit stresses for bearing on inclined surfaces of timber, as shown by Fig. 3 and 4 differ materially. The effect on the design of a truss joint from using the two sets of allowable pressures will be shown in a subsequent article. Mr. Jacoby's curve is the more economical in material, but the results of Mr. Howe's tests are not to be ignored. The data available at present should be supplemented by further tests.

Details of beveled cast-iron washers are shown in Fig. 5. Attention is called to the thickness of the base of these washers. It is intended that the washers should be set into the timber to the depth of the base plate. For inclined bolts or rods, the use of these washers will give a neat and efficient detail, and one comparatively easy to construct.

Resistance of Timber to Pressure from a Cylindrical Metal Pin. The bearing of a round metal pin in a closely fitting hole in timber, as occurs in the case of a spike, screw, or bolt with a driving fit, is a special case of bearing on inclined planes. The subject is discussed in Jacoby's 'Structural Details,' Chapter II, Article 23, where the following statements are made:

"In framing, it is sometimes necessary to use metal pins or bolts as beams in transferring stresses from one timber to another. This involves the determination of the pressure of the fibres of the wood upon the cylindrical surface of the pin. When the resultant of the pressure is perpendicular to the fibres of the wood, the magnitude of the resultant is the same as if the bearing surface were the diametral section of the pin. But when

[2] *Cornell Civil Engineer*, Vol. 23, No. 2.

[3] *Engineering News*, Volume 68, No. 5.

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the direction of the resultant is parallel to the fibres of the wood, the case is entirely different because the resistance of the fibres to lateral compression is much less than to longitudinal compression."

The following formulæ are deduced by Jacoby:

Let

P = the total safe load on the pin

h = height of the timber bearing against the pin

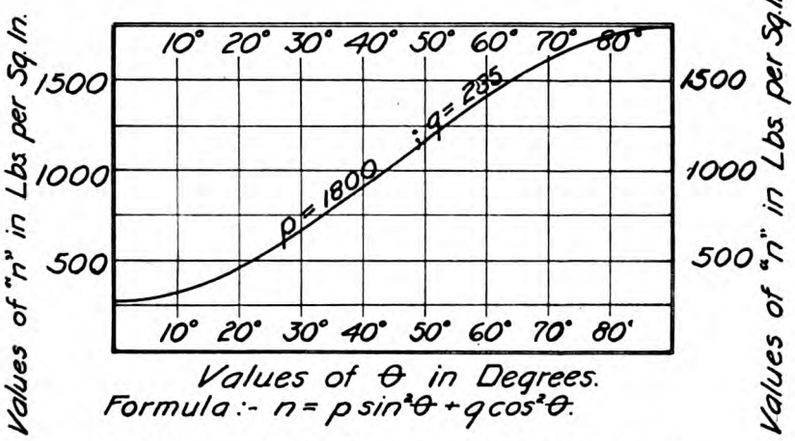

FIG. 3. CURVE FOR DOUGLAS FIR BASED ON JACOBY'S FORMULA.

n = normal intensity on inclined planes.
p = normal intensity on ends of fibres.
q = normal intensity across fibres.
Θ = angle made by plane with direction of fibres.

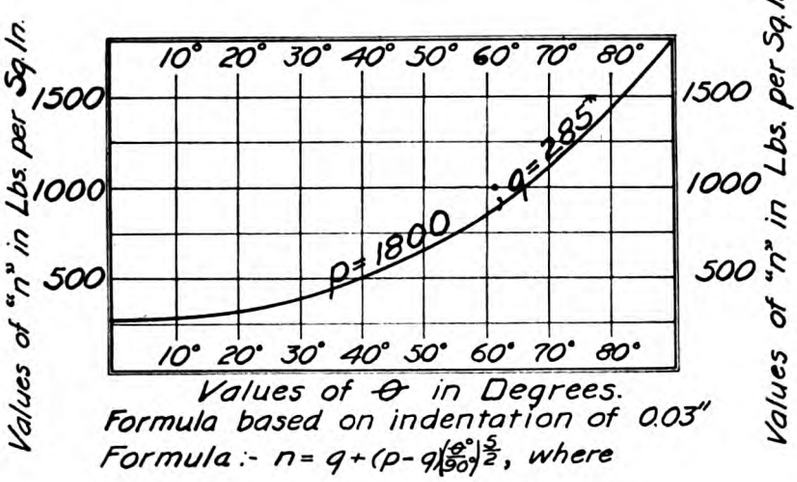

FIG. 4. CURVE FOR DOUGLAS FIR BASED ON HOWE'S FORMULA.

n = normal intensity on inclined planes.
p = normal intensity on ends of fibres.
q = normal intensity across fibres.
Θ = angle made by plane with direction of fibres.

d = the diameter of the pin

p = safe unit stress for compression parallel to the fibres, or for bearing on the ends of the fibres

q = safe unit stress for compression perpendicular to the fibres, or across the fibres

u = the unit pressure normal to the surface of the pin

Θ = the angle which u makes with the direction of the fibres (complement of angle Θ used above)

Θ' = the special value of Θ for which the transverse component of $u = q$

"For wood having a ratio of 0.25 between the safe unit bearing on side and on the end of the fibres, respectively, $\Theta' = 15°$, and $P = 0.62\ hdp$. An experimental determination for long-leaf yellow pine, but in which the timber was tested to its ultimate strength, gave an average coefficient of 0.63 for 5 tests. The specimens were prevented from splitting by means of clamps. The plane of division between the fibres crushed sidewise was marked in every case, and gave an average value for Θ' of $15\frac{1}{2}°$. When the resultant of the pressure of the wood on a round pin is perpendicular to the fibres, the magnitude of the safe bearing value is to be taken as hdq, that is, the pressure is the same as if the pin were square or rectangular in cross-section."

With the preceding theory, and in particular with the statement as to the bearing across the grain, I am not in accord. The tests on spiked, screwed, and bolted joints do not show the difference in strength between end and cross-bearing that the theory would indicate exists, as will be seen from the record of the tests to be given later.

The following theory is presented to cover the case now under discussion. Fig. 6 shows the case of a cylindrical metal pin bearing against the ends of the fibres and across the fibres, respectively. Let the nomenclature be as before, with the additional terms, as follows:

n = safe unit stress for compression on a surface inclined to the direction of the fibres

s' = the component of n, parallel to the direction of fibres

s'' = the component of n, perpendicular to direction of fibres.

If the assumption be made that the various differential inclined surfaces will resist pressure simultaneously, in radial lines, equivalent in amount to the allowable unit stress, n, and if the law of variation of pressures on inclined surfaces be known, the capacity of the timber or the safe load on the pin may at once be determined. For example, let it be assumed that the law governing the allowable pressures on inclined surfaces is according to Jacoby's formula, and that

$$n = p \sin^2 \Theta + q \cos^2 \Theta$$

Then, referring to Fig. 6

$$s = n \sin \Theta = (p \sin^2 \Theta + q \cos^2 \Theta) \sin \Theta$$

The pressure s' acts upon the differential area $hr \cos \Theta\, d\Theta$

Therefore

$$P = 2phr \int_{0°}^{90°} \sin^2\theta \sin\theta\, d\theta - qhr \int_{0°}^{90°} \cos^2\theta \sin\theta\, d\theta$$

Integrating and substituting the limits,

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$P = \frac{2}{3}\,phd + \frac{1}{3}\,qhd$

For a pin of diameter of 1 in. and length of 1 in., P will represent the average unit stress on the diametral section of the pin $= p'$

or p' (unit stress in lb. per sq. in.) $= \frac{2}{3}\,p + \frac{1}{3}\,q$.

Similarly, for the case of Fig. 6, where the direction of P is perpendicular to the direction of the fibres, it may be shown that

$p'' = \frac{1}{3}\,p + \frac{2}{3}\,q$, where p'' = average unit stress on diametral section of the pin.

Using the values of 1800 lb. per sq. in. and 285 lb. per sq. in. for p and q, respectively, in the above formula,

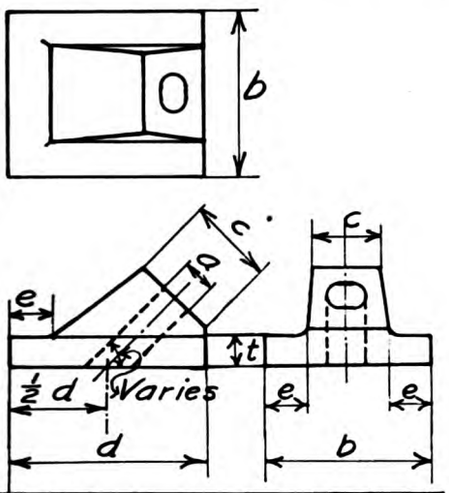
$p' = 1295$ lb. per sq. in., and that

$p'' = 790$ lb. per sq. in.

If, on the other hand, the variation of the pressure on inclined surfaces be taken from Howe's formula, and the same numerical values for p and q used as before, it may be shown that

$p' = 1120$ lb. per sq. in., and that

$p'' = 675$ lb. per sq. in.



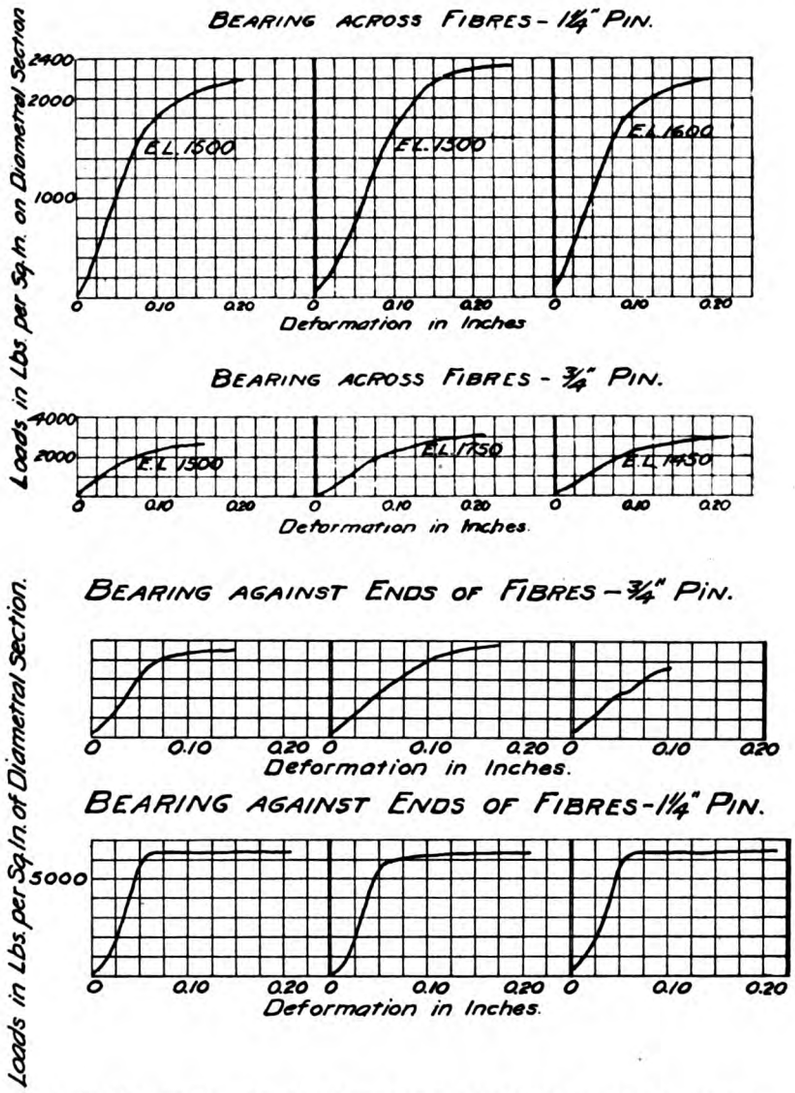
Size Rod	a	b	c	d	t	e
3/4	7/8	3½	1¾	4	5/8	3/4
7/8	1	4¼	2	4½	3/4	1
1	1⅛	4¾	2¼	5¼	7/8	1⅛
1⅛	1¼	5¼	2½	6	1	1¼
1¼	1⅜	6¼	2¾	6½	1	1½

FIG. 5. DETAILS OF BEVELED CAST-IRON WASHERS.

In an effort to throw light on this question, I tested a number of small blocks of Douglas fir, made with half holes, and each fitted with a short piece of bolt having a tight fit in the holes. Two sizes of bolts were used, one ¾-in. diameter, and the other 1¼-in. diameter. The tests were made both for bearing against the ends of the fibres and across the fibres. The details of the test pieces are shown in Fig. 7, while the stress deformation curves are shown in Plates V and VI.

The results are not determinate. While the stress deformation curves for the two sizes of bolts bearing across the fibres show the same value (approximately) for the elastic limit, there is quite a variation in the curves for end bearing, although the ultimate strengths are nearly the same. The blocks with the 1¼-in. pins were much better specimens, both in respect to quality of timber and grade of workmanship than those with the ¾-in. pins, as the end cuts of the latter were not true. However, all uneven blocks were shimmed, and it is not probable that the difference in strength was due altogether to either quality of timber or workmanship.

The elastic limit for bearing across the grain is seen to be approximately 1500 lb. per sq. in., while for bearing against the ends of the fibres, the ultimate strength is approximately 4000 lb. per sq. in. in the case of the ¾-in. pin, and 6000 lb. per sq. in. in the case of the 1¼-in. pin, or an average of 5000 lb. per sq. in. The tests were not sufficient in number, nor were the blocks made carefully enough to use the results as working data. They do indicate, however, that the pressure of a circular metal pin in a timber block is a function of the relative resistances of the timber for compression against the ends of the fibres and across the fibres.



PLATES V AND VI. STRESS DEFORMATION CURVES FOR PINS IN TIMBER.

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Joints Framed With Shear Pins. Fig. 8 shows a detail of a joint in which circular pins of metal or hardwood are used to transmit stress. The detail is one which was used extensively in the framing of Exposition buildings, for splicing tension members of trusses, fastening bolsters on columns to receive the ends of

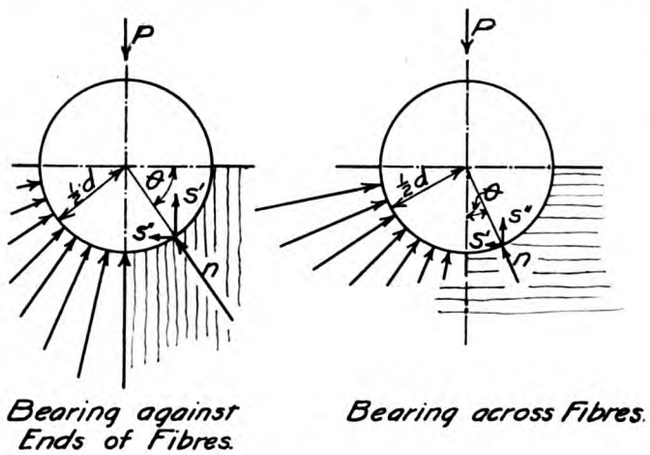

FIG. 6. DIAGRAM SHOWING PRESSURE OF ROUND METAL PIN IN TIMBER.

beams, girders, knee-braces or trusses. The resistance of such a joint involves several elements, namely, strength of the pins in shear, resistance of the pins to distortion, bearing resistance of the timber, both against the ends of the fibres and across the grain, and the strength of the bolts in bending, shear, and tension.

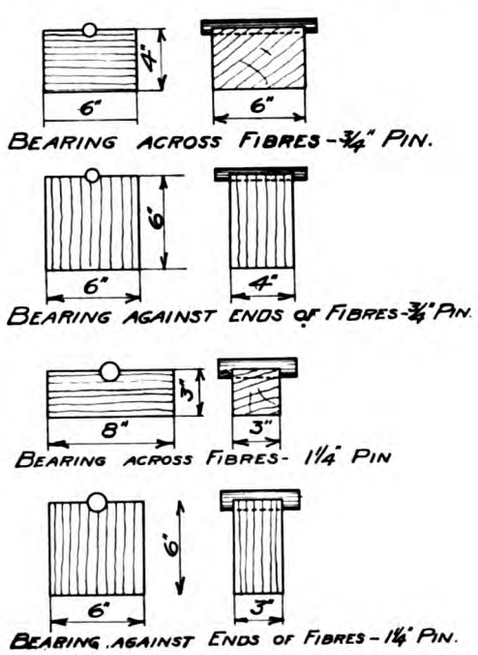

FIG. 7. DETAILS OF TEST-PIECES USED IN PIN EXPERIMENTS.

The method of framing the connection, when used as a tension splice is as follows. Two splice-pads are spiked on the sides of the main timber. The bolt holes are bored, the bolts are driven and the nuts tightened. The holes for the pins are then bored, and the pins driven. A close fit for all pins is thus assured with a minimum amount of labor. The joint has certain obvious advantages over some of the splice-joints which are in general use in timber framing. It does not depend in its action upon difficult and expensive cuts and daps of the timber, and is much cheaper than a joint composed of steel fish-plates with attached lugs.

A number of tests of such joints were made in 1913, and described in detail in *Engineering News,* Vol. 71, No. 12, and Vol. 72, No. 9. The materials used were oak, common gas pipe, full weight steel pipe, 1½-in. extra heavy pipe, solid steel, Hawaiian Ohia, Australian hickory, and Australian ironbark. All pins were 2 in. diam.

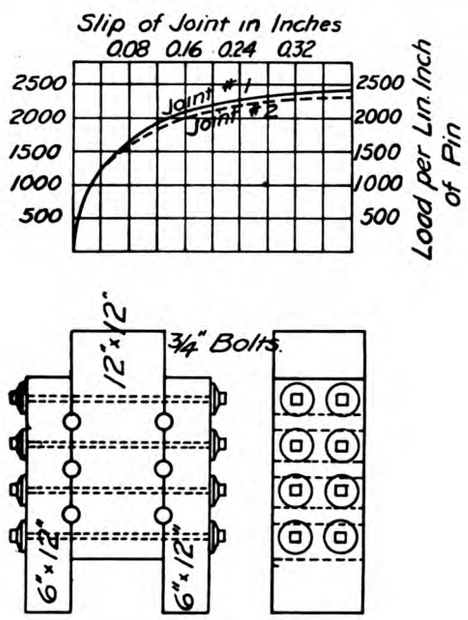

FIG. 8. CURVE FOR AUSTRALIAN IRON BARK AND TEST JOINT FRAMED FOR 2-IN. PINS. BOLTS AND PINS, 6-IN. CENTRES.

The ultimate strength of the joints expressed in pounds per linear inch of pin ranged from 1950 lb. for the gas pipe pins to 2800 lb. for the Ohia pins. The slip of the joints at these loads was about ⅜ in. The average load at the apparent yield point was approximately 1800 lb. per linear inch of pin, with a slip of 0.03 in. From the results of the tests, it may be stated that joints of this kind may be framed using 2-in. pins of extra heavy steel pipe, solid steel pins, pins of Hawaiian Ohia and of Australian iron bark, with working loads of 800 lb. per linear inch of pin. Sufficient bolts must be provided to take a total stress of one-half the load on the joint.

The validity of the assumptions on which the formulae for average unit bearing-pressures on pins are based may be questioned. While it is not contended that the pressure distribution on a circular pin is accurately known, the formulae have a rational basis, and give results that are in approximate accord with such tests as have been described, and others which will be discussed in a subsequent article. The factors entering into any theoretical solution of the question are many and complex, and absolute working values may be assured only through further tests.

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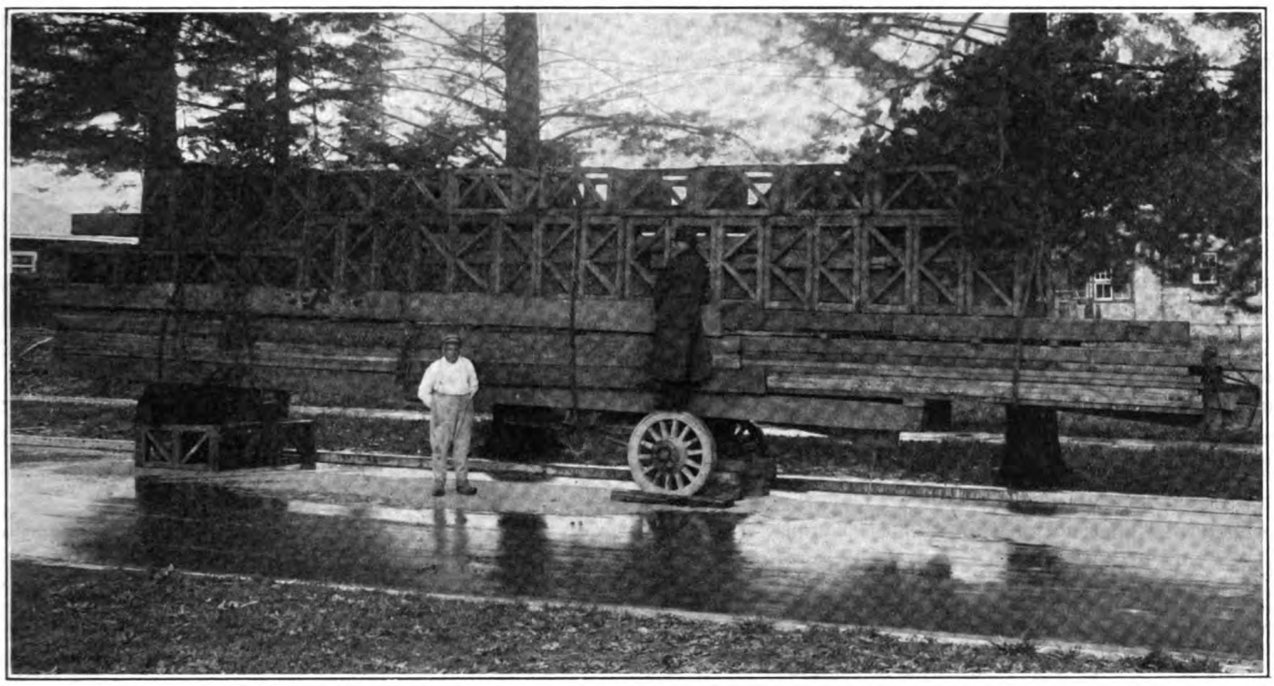

LOAD OF 40,797 LB., 28,557 LB. ON TWO REAR TIRES AND 2856 LB. PER INCH OF TIRE, WHICH PASSED OVER EL CAMINO REAL WITHOUT MARKING THE SURFACE.

Pavement Construction in Burlingame, California

By ERIC WOLD*

The summer of 1912 brought a large reduction in the prices of pavements throughout California. This reduction was due to the many large contracts which were awarded during the year and also to the increased competition caused by the entry of new paving companies into the field. Up to that time a bid of 18 cents per sq. ft. for a 4-in. concrete base and 2-in. asphalt top was considered a fairly low bid, and a 12-cent bid for 6-in. of oil macadam was as low as might be expected. That year, however, brought a decided reduction in paving prices. I awarded one contract on August 28, 1912, for a pavement consisting of a 4-in. hydraulic concrete base and 1½-in. asphaltic wearing surface for 12 cents per sq. ft. Even the property owners considered that the price was too low and that a good job could not be obtained at such a figure. However, during the years 1913, 1914, and 1915, during which time most of the $18,000,000 California State Highway and the $1,250,000 San Mateo County Highway were constructed, besides numerous large jobs in several cities and counties of the State, prices varied between 11 and 13 cents per sq. ft. for pavements similar to that specified above. The size of most of these jobs ranged from 300,000 to 750,000 sq. ft. The results have been gratifying. The contractors have brought the efficiency of their organizations up to a high standard and the material men have increased the efficiency of their plants and the grade of their products. The general public reaps the benefit.

On February 29, 1916, the City of Burlingame received bids on what I believe is the first large paving job to be awarded this year in the State. The prices named in the successful bid would appear impossible at first glance. The work consists of paving all the streets of the Easton Additions and the Burlingame Grove Addition, with a 4-in. hydraulic concrete base and a 1½-in. asphaltic wearing surface mixed according to the Topeka specification. The total length of the streets to be paved is 10¾ miles and the average width, 30 feet.

In this connection the experience of Burlingame with topeka pavement is of interest. When I specified topeka pavement at Burlingame five years ago, there was a great deal of argument as to the qualities of what the warrenite advocates call "The bastard pavement." The pavement on El Camino Real, a link of the State Highway, which is the only continuous north and south road or street through the City of Burlingame consists of 1½-in. topeka pavement laid on a 5-in. concrete base. This road probably receives the heaviest traffic of any road in the State. It is the favorite road of the automobilist and a large part of the freight between the various peninsula towns between San Jose and San Francisco follows this route. The road was constructed in the winter of 1912-13, and, in spite of all the wear it has ex-

*City engineer, Burlingame, California.

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perienced, it is in first-class condition today. Topeka has proved itself an "A No. 1" pavement—having the wearing qualities of sheet asphalt and the non-skidding properties of warrenite.

The Easton-Burlingame Grove improvement was instituted under the Improvement Act of 1911 with the Bond Act provisions of 1915. Under the provisions of this Bond Act, the bonds for unpaid assessments are not issued against the individual lots or parcels of land, but against the entire district and in such denominations as the Board of Trustees may desire. The city tax-collector makes the collections of interest and partial payments. The bonds for this improvement bear 6% interest, and I understand that 97.5 was offered for the bonds at the time of bidding.

The following are the quantities upon which the contractors bid, also the prices named by the lowest bidder, the Federal Construction Co. of San Francisco:

Item	Quantity	Unit Price	Total
Gutter	112,245 lin. ft.	$0.18	$20,204.10
Paving	1,625,051 sq. ft.	0.0867	140,891.92
Curb	55,357 lin. ft.	0.32	17,714.24
Sidewalk	23,098 sq. ft.	0.12	2,771.76
Grading	1,787,783 sq. ft.	0.015	26,816.74
6-in. V. C. storm sewer	481 lin. ft.	0.30	144.30
8-in. V. C. storm sewer	5,090 lin. ft.	0.35	1,781.50
10-in. V. C. storm sewer	815 lin. ft.	0.50	407.50
12-in. V. C. storm sewer	1,507 lin. ft.	0.69	1,039.83
18-in. V. C. storm sewer	525 lin. ft.	1.19	624.75
18 by 18-in. inlets	48	10.00	480.00
24 by 24-in. inlets	54	18.00	972.00
3 by 7-ft. concrete storm sewer	4,630 lin. ft.	5.00	23,150.00
4 by 10-ft. concrete storm sewer	630 lin. ft.	7.78	4,901.40
1 by 2-ft. concrete storm sewer	921 lin. ft.	1.00	921.00
10-ft. concrete bridge	each	500.00	500.00
10-in. corrugated-iron pipe	388 lin. ft.	1.00	388.00
12-in. corrugated-iron pipe	15 lin. ft.	0.20	3.00
6-in. V. C. sanitary sewer	900 lin. ft.	0.50	450.00
8-in. V. C. sanitary sewer	2,216 lin. ft.	0.60	1,329.60
12-in. V. C. sanitary sewer	21 lin. ft.	1.53	32.13
4-in. sewer laterals	4,146 lin. ft.	0.25	1,036.50
4 by 6-in. wyes	41	1.00	41.00
4 by 8-in. wyes	33	1.00	33.00
4 by 12-in. wyes	7	1.94	13.58
Manholes	6	35.00	210.00
Curb irons	1,352 lin. ft.	0.20	270.40
Total			$247,128.25

The following is a summary of the specifications for the work: The pavement consists of a 4-in. hydraulic concrete base and 1½-in. topeka wearing surface.

Concrete Base: One part of portland cement by measure and three parts of sand by measure shall make the mortar. This mortar shall be mixed with the rock aggregate and water in such proportions as to fill completely the voids of the same and flush to the surface when tamped. Either gravel or crushed rock may be used.

Asphaltic Mixture: The asphaltic concrete shall have the following proportions:

Bitumen	8 to 12%

Mineral aggregate passing screen	Retained on screen	%
200	...	8 to 12
100	200	5 to 10
40	100	15 to 25
10	40	22 to 49
4	10	8 to 22
2	4	Less than 10

Of the above aggregate 7 to 11% must be marble dust.

There are several reasons why these low prices should be obtained at this time.

1. The new 1915 Bond Act places all the bonds of the district affected on the same footing, the issue being against the entire property benefited. Under the old Bond Act the contractors were able to dispose of the bonds against the good property, while those against the poorer lots and against corner lots with large assessments were left on the contractor's hands, thus tying up his working capital. The present condition of the bond market has also had a tendency to result in low bids, the market for these bonds being exceptionally good.

2. The size of the job also favored low prices. The cost of moving or erecting plant is a considerable proportion of the contract price and the wholesaler of any commodity naturally operates with a smaller margin of profit than the retailer.

3. The fact that this was the first important contract to be awarded in California this season, at a time when the majority of contractors were idle, also had a tendency toward low prices; for the contractor must keep up his organization even though he has no work on hand. He keeps his asphalt-plant man or men and certain foremen and superintendents on his payroll whether he has work to do or not, and the office overhead never stops. Hence work at this time even at low proportion of profit is better than the loss due to no work at all.

4. The efficiency of the material men and their equipment in this section is also instrumental in producing low cost. The San Mateo Development Co. operates a quarry and stone-crusher within four miles of the work. The Excelsior Lumber Co. has constructed bunkers on a spur track and is able to handle economically from 15 to 20 carloads of crushed rock, sand, or gravel per day. The contractor need never be held up for his materials and will, therefore, be able to complete his job in record time. I have estimated that the contractor will finish this work in from four to five months from the day it is begun.

5. The prices of materials were low at the time of letting of this contract. Cement could be delivered on the street for $2.10 per bbl., crushed gravel for $1 per ton, sand for $1 per ton, asphalt at the plant in tank-car lots for $8 per ton and marble dust at $5 per ton. Since the award of the contract the price of asphalt has risen $1 per ton.

The cost of the reinforced concrete storm-sewers included in the contract was also unusually low. The total cost of the sewers was $29,000. The section of the 4 by 10-ft. box-sewer is shown in Fig. 1.

The storm-water drainage of this district was a serious

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problem; first, because of the large tributary drainage area, 2580 acres in all; second, because of the light grades and low elevation of the land, necessitating shallow and wide sewers and bringing the cost to almost prohibitive figures. By including this work with the

PAVEMENT ON EL CAMINO REAL AFTER THREE YEARS OF SERVICE.

other improvements of this district the cost to the property owners has been reduced materially.

When this work is completed Burlingame will have 29 miles of pavement consisting of hydraulic concrete base and asphaltic wearing surface, accepted by the city for a term of twenty years. This is 93% of the total mileage of streets.

There will also be 58 miles of cement sidewalks, or 93% of the total mileage, as well as a complete sanitary-sewer system consisting of main sewers and a lateral to each lot in the city, excepting the Terrace Addition, for which, however, plans are being prepared at the present time. The Pacific Gas & Electric Co. will have its gas mains on every street with necessary service pipes run to the curb lines. The municipal water works will have its mains on every street of the city, giving ample fire protection with 90 to 100 lb. pressure, and domestic service pipes to the curb lines. There are 400 street lights, one in each block, and electroliers on the main streets, service being furnished by the Pacific Gas & Electric Company.

Since the contract involved a large amount of money and the constitutionality of the 1915 Bond Act was questioned, as well as to clear up certain irregularities in the proceedings, it was agreed to bring the matter before the Appelate Court in a friendly suit. A decision was rendered on April 24, 1916, the portion relating to the constitutionality of the Act being as follows:

"This is an application for a writ of mandate directing the superintendent of streets of the City of Burlingame. The petitioner is the contractor to whom was awarded the contract for the doing of certain street work and other work in said city under the Improvement Act of 1911 (Stats. 1911, approved April 7, 1911), and the Improvement Bond Act of 1915, (Stats. 1915, approved June 11, 1915). It is sought to obtain the order of this court that the respondent should enter into the contract with the petitioner for the doing of said work. The respondent (Eric Wold, as superintendent of streets of the City of Burlingame) has declined to sign said contract upon the ground, amongst others, that said Bond Act is unconstitutional.

"With reference to the constitutional point, it appears that the Bond Act of 1915 provided that the municipality, in the absence of any other purchasers, must pur-

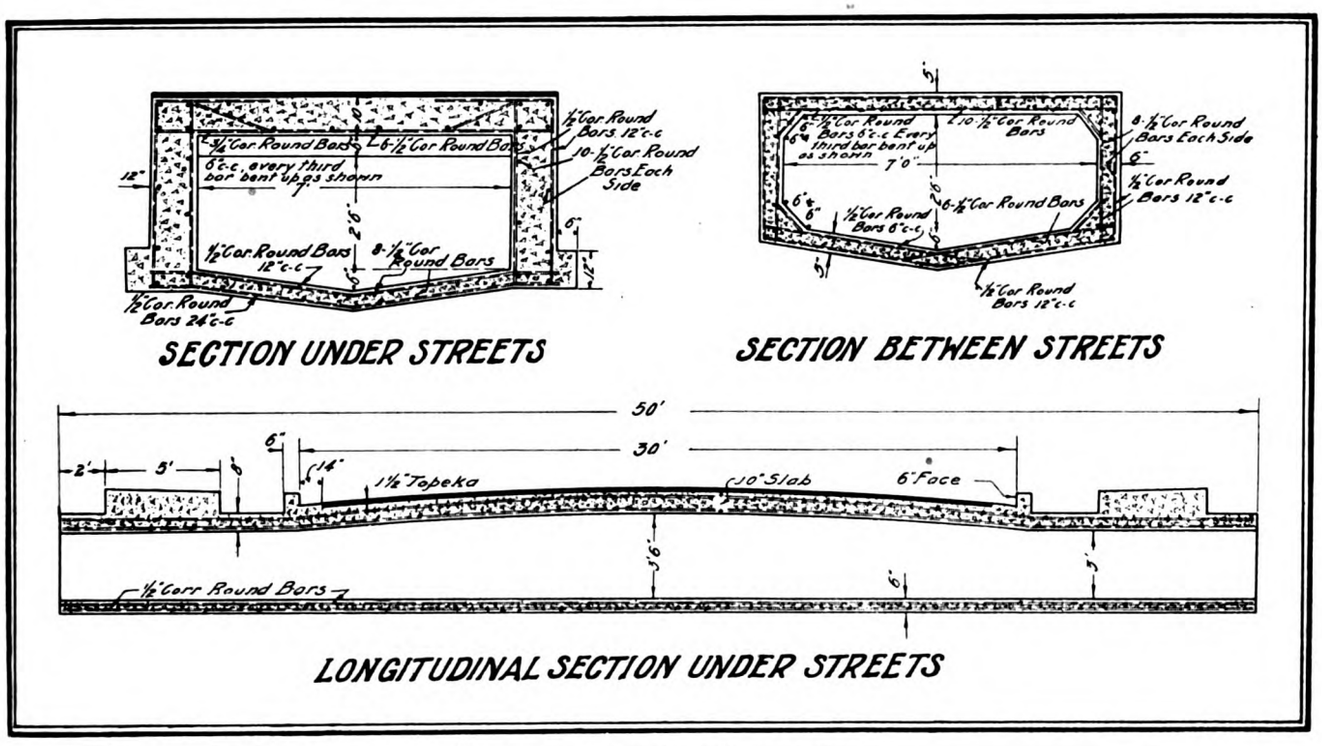

FIG. 1. SECTION OF 4 BY 10-FT. BOX SEWER.

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chase all property offered at delinquent sales for the non-payment of street assessments. It is contended that such a provision is in effect an incurring of liability not to be satisfied during the current fiscal year in which the same is incurred, and not supported by a two-thirds vote of the electorate, and hence violative of section 18 of Art. XI of the State Constitution. This objection, if tenable, would render merely the provision requiring the municipality to purchase property offered at delinquent tax sales unconstitutional. It would not affect the validity of the balance of the act. However, it has been held that this section of the constitution only refers to the act or contract of a municipality and not to liabilities which the law places upon municipalities (Lewis *vs.* Wilber, 99 Cal. 412; Welsh *vs.* Strother, 74 Cal. 413; Cashin *vs.* Dunn, 58 Cal. 581).

"Furthermore, it appears that under Sec. 11 of this so-called Bond Act of 1915 a municipality can escape the responsibility for the purchase of property by providing for the collection of delinquent assessments by foreclosure suits. The liability, therefore, is in effect contingent upon the future acts of the municipality, and would not be within the constitutional restriction.

"A preemptory writ of mandate will, therefore, be issued forthwith in conformity with the prayer of the petitioner on file."

MANHOLE CONSTRUCTION IN QUICKSAND

The report of the Committee on Underground Construction presented at the annual convention of the National Electric Light Association describes a novel method of constructing manholes in a sandy soil where the permanent water-level is two or three foot from the surface. The excavation to the quicksand is made in the ordinary manner. Then a wooden framework is built, having the same horizontal section as the manhole walls. This framework is made of 2-in. planks and is 6 in. thick in all. The corners are well fastened so as to make diagonal bracing unnecessary. The framework is placed in a level position on the quicksand, and the manhole is built of brick to the required height, the walls being well plastered on the outside.

After the mortar has set for three or four days, the excavation proceeds. By digging along the walls inside the manhole and under the wooden framework, the structure will usually settle to the required depth. During the excavation, only sufficient water should be removed to allow the men to work to advantage, as otherwise the sand becomes hard. If the settlement is slow, it can be accelerated by placing bags of sand or other weights on top of the manhole walls. The excavation and the settlement of the structure to the required depth will not require more than eight or ten hours unless obstructions are encountered. After the manhole has reached the proper depth, the settlement is stopped by back-filling the excavation and tamping around the outside of the manhole walls. Upon completion of the settlement, the water is removed from the manhole, the sand excavated to the level of the bottom of the wooden framework, and a heavy concrete bottom is placed in the manhole. The openings for the conduit are cut in the wall of the manhole after it is entirely completed and settled to the proper depth.

The cost of labor is about double that of the ordinary manhole. The wooden framework is the only other additional item of expense.

HAULING AND HANDLING MATERIALS FOR CONCRETE HIGHWAYS

Methods of hauling and handling concrete materials were the subject of a report to the National Conference on Concrete Road Building by a committee composed of T. R. Agg, chairman, H. G. Shirley, Edward N. Hines, R. N. Waid, and E. H. Cowan.

Team-hauling, using a bottom-dump wagon, is recommended where the material must be hauled from a congested freight-yard through a congested business-district, and finally over unimproved earth roads. It is seldom economical for hauls over two miles. Where conditions are such that teams cannot haul as many as three 2-yd. loads during the day, it is probable that motor trucks will be more economical. A three-ton truck designed for high speed will usually be found more economical than a heavier, slower-moving truck. When the roads are soft, trucks may work at a disadvantage as compared with teams, particularly in wet weather. Tractor-trains are less adaptable to diverse conditions than either motor trucks or teams. The weight of each unit is limited by the danger of damage to the roadway. It is probable that the weight of each truck and load should not exceed six tons and even for such trucks the wheels should be six inches wide. Slippery roads interfere seriously with tractor-hauling. Where the haul exceeds two miles and where ample switching facilities and storage bins can be provided, an industrial railroad will often be found to be economical. The cost of tracks is the heaviest expense. Where grades are greater than 4%, geared locomotives must be used and the carrying capacity of the railroad is reduced. Where grades are less than 4%, an average speed of eight miles per hour can be maintained. The industrial railroad is practically independent of weather conditions.

When the job is a small one and teams are used for hauling, the materials may be unloaded to a storage-pile. Where any other means than teams are used, a storage-pile is objectionable, because of the high cost of reloading, and storage-bins should be provided. Where several miles of highways are to be built, it will be found economical to unload the material from the cars to the storage-bins by mechanical means, such as a locomotive crane, bucket-elevator, or belt-conveyor. At the mixer-end of the work, if any system is used which involves dumping the materials on the subgrade or shoulders, wooden platforms should be employed. Industrial-railroad cars can be arranged to dump direct into the mixer.

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Forms for Concrete Work*

By R. A. SHERWIN†

Numerous cost-analysis diagrams prepared in our office from the actual costs of average reinforced concrete buildings of the industrial type, not taking into account the cost of any equipment, show that the labor on forms averages about one-third the labor cost, and the lumber about one-tenth of the total material cost, including sub-contracts. The total labor cost is usually about 35% of the cost of the building. The design and erection of forms is, therefore, the most important single item in concrete building construction and one upon which much thought and study can be well spent.

Economical forms must be designed as light and with as few sticks as possible to give the necessary strength and stiffness. You will note I say "necessary," for this is the point to keep in mind. We must remember on the one hand that human lives and the cost of failure, both in money and reputation, are dependent upon the design, and, on the other, that forms are temporary structures loaded fully for a short time only. A low factor of safety is therefore allowable.

The main question, then, is one of strength with enough stiffness to prevent any appreciable sags in the finished concrete. Any slight deflection that might occur in the timbers themselves is taken care of in the camber always given horizontal members in erection.

The floor timbers should be designed for the full live and dead load, but any serious deflection will be caused only by the dead weight of the wet concrete. The full live and dead load can act together for only a short space of time. Therefore I think that limiting the centring by small deflections and using full live and dead load is questionable practice. One place where deflection should be carefully guarded against is at the window-head. At this point a slight deflection will cause much trouble and expense in setting the sash.

The principal cause of settlement of form work is crushing of the soft spruce or pine lumber perpendicular to the grain in the girt over the post, and also in the adjustment of the wedges under the posts as the full load is applied. In this connection, Professor Johnson, on page 468 of his 'Materials of Construction,' says: "Since timber is very weak in crushing across the grain, as compared to crushing endwise, this is found to be one of the most common methods of failure in practice. It is common to rest a timber column on a sill of the same wood and to design the column for its maximum working load, paying no attention to the utter inability of the sill to carry this load without crushing. Many failures of timber structures are due to this cause alone." An average safe value to use in form design for this crushing stress, as determined by numerous tests, is 400 lb. per square inch for spruce. Considering this stress, a 4 by 4-in. spruce post under a 4-in. wide girt is good for 6400 lb. The trouble due to wedges can be almost entirely eliminated by using large hardwood wedges. If the posts are cut square at the ends to give an even bearing and heavy wedges used to bring the posts to grade, no settlement will occur.

Posts are usually placed on a plank sill. When these sills are laid on the ground great care is needed in order to avoid settlement because of deflection in the plank when a hollow place comes under the post. This often occurs when sills are placed on frozen ground, and salamanders thaw out portions of the surface and cause soft places under the sills. When light sills are placed on a rough concrete floor, deflection is liable to occur unless care is taken to give the sills an even bearing. For these reasons I believe that limiting the floor timbers to small deflections and at the same time using high loads on the posts is not consistent, and surely not economical.

Design. The first thing to be done in preparing a form design for a concrete structure is to make a careful analysis of the plans submitted by the engineer. This should be done as soon as the preliminary plans are available, for many details which seriously affect both the progress of the work and the cost of the forms may be brought to the engineer's attention and changes made for the benefit of the owner. These points are often overlooked by the engineer, who does not always look at the structure from the construction point of view. Chief among these points is that of story heights. It is desirable that these heights be kept uniform throughout the building so that the column forms can be re-used from story to story without either cutting off or splicing. Failing this, it is better to have the high stories at the bottom, as cutting off forms is much cheaper than splicing them.

Another important point is that of joints. I refer only to construction joints. These should be planned and the reinforcement detailed so that the forms can be erected in the simplest possible manner. These joints should, of course, come at a natural stop for a day's work and be located so that they will least affect the appearance of the finished structure. The position and detail of any expansion joints should be determined early, as they will affect the form design and probably require special study.

An example of a detail to be considered in connection with the question of joints is the important one of making the dowels for the column rods long enough so that the necessary lap will come above the point where

*Abstract from paper presented at the convention of the American Concrete Institute, Chicago, February 1916.

†Engineer, Aberthaw Construction Co., New Haven, Conn.

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the column forms will actually start. For example, it is not uncommon to find a wall beam, which comes above the slab, detailed so that it must be cast with the floor, but at the same time to find the lap for the column rods shown above the top of the slab instead of above the top of the wall beam, as it should be. It is economical to cast a curtain-wall beam, used sometimes in mushroom construction, as a later operation. The forms can be made and erected more cheaply. This can easily be arranged for by providing pipe sleeves through the column to take the negative-stress rods and a slot in the column as a seat for the beam.

The kind of windows must be decided upon at once so that the necessary groove strip can be scheduled and attached to the column sides and beam bottoms.

The floor finish will affect the form design. Questions as to the thickness of wood floor, or if granolithic, whether it is to be placed with the slab or as a separate operation, must be decided before the form design can proceed.

In calculating the sizes of form members, we do not use a standard set of loadings, formulae, etc, for all cases, but treat each one separately, according to conditions. In general we use the following values:

Dead weight of concrete	150 lb. per cu. ft.
Construction live load on floor forms	75 lb. per sq. ft.
Pressure of concrete on columns and walls per foot of depth	140 " "
Coefficient of elasticity for spruce or equal	1,200,000
Extreme fiber stress in spruce or equal:	
For timbers	1200 lb. per sq. in.
For column yokes	1800 " "
Horizontal shear for spruce or equal	200 " "
Crushing perpendicular to grain in spruce or equal	400 " "

The proper value for the equivalent hydraulic pressure of concrete to use in form design has been variously estimated all the way from 75 lb. per sq. ft. of depth to twice that amount. The value of 140 lb., noted above, will give safe results and is based on actual experiments under job conditions.

Timbers used as joists to support the floor forms are figured for the full live load of 75 lb. per sq. ft. plus the dead load of the slab, on jobs where side-dump cars carrying a four-bag batch of concrete are used for distribution. Table I has been prepared on this basis, using the simple beam formula. This will take care of the worst case and places the greatest factor of safety where it is most needed.

On jobs where buggies, barrows, or chutes are used for placing concrete, the spacings and spans given in the table can be increased because the live load will be a great deal less. It is doubtful if the full live and dead loads act at the same time in any case.

The span of the joist is usually fixed by the position of the girts. The position of the latter is determined by the column spacing in a mushroom floor and by the beam spacing in beam and girder construction. The spacing of the joists is kept as near 24 in. as possible in order to work the ¾-in. panel decking to the limit. The spacing of joists once determined should be kept standard for the job, so that when the panels are re-used their cleats will not interfere with the joists previously placed.

TABLE I. SPACINGS AND SPANS FOR JOISTS

Slab Thickness, ins.		3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
Weight, lbs. per sq. ft.[1]		112.5	125.0	137.5	150.0	162.5	175.0	187.5	200.0	212.5	225.0
Size of Joists, ins.	Spacing of Joists, ins.	Span of Joists in Feet.									
2×6[2]	18	7.2*	6.9*	6.5*	6.3	6.0	5.8	5.6	5.4	5.3	5.1
"	20	6.9*	6.5*	6.2	5.9	5.7	5.5	5.3	5.1	5.0	4.8
"	22	6.5*	6.2	5.9	5.7	5.4	5.2	5.0	4.9	4.8	4.6
"	24	6.3	5.9	5.7	5.4	5.2	5.0	4.8	4.7	4.6	4.4
"	26	6.0	5.7	5.4	5.2	5.0	4.8	4.7	4.5	4.4	4.2
"	28	5.8	5.5	5.2	5.0	4.8	4.7	4.5	4.4	4.2	4.1
"	30	5.6	5.3	5.1	4.9	4.7	4.5	4.3	4.2	4.1	4.0
2×8[3]	18	9.7*	9.2*	8.8	8.4	8.1	7.8	7.6	7.3	7.1	6.9
"	20	9.2*	8.8*	8.3	8.0	7.7	7.4	7.2	6.9	6.7	6.5
"	22	8.9*	8.4	8.0	7.6	7.3	7.1	6.8	6.6	6.4	6.2
"	24	8.4	8.0	7.7	7.3	7.1	6.8	6.5	6.3	6.1	6.0
"	26	8.1	7.7	7.3	7.0	6.7	6.5	6.3	6.1	5.9	5.6
"	28	7.8	7.4	7.1	6.8	6.5	6.3	6.1	5.9	5.7	5.5
"	30	7.5	7.2	6.8	6.5	6.3	6.1	5.9	5.7	5.5	5.3
2×10[4]	18	12.2*	11.6*	11.0*	10.6	10.2	9.8	9.5	9.2	8.9	8.7
"	20	11.6*	11.0*	10.5	10.0	9.7	9.3	9.0	8.7	8.4	8.2
"	22	11.1*	10.5	10.0	9.6	9.2	8.9	8.6	8.3	8.0	7.8
"	24	10.6	10.0	9.6	9.2	8.8	8.5	8.2	8.0	7.7	7.5
"	26	10.5	9.6	9.2	8.8	8.5	8.2	7.9	7.6	7.4	7.2
"	28	9.8	9.3	8.9	8.5	8.2	7.9	7.6	7.4	7.1	6.9
"	30	9.5	9.0	8.6	8.2	7.9	7.6	7.3	7.1	6.9	6.7

[1]Weight includes dead load of slab plus 75 lb. per sq. ft. live load.

[2]Span which will develop 1200 lb. per sq. in. fibre stress and deflection of

$$\frac{\text{Span (in.)}}{360} = \frac{48 \times 5.75 \times 1{,}200{,}000}{5 \times 360 \times 1200 \times 2} = 77 \text{ in. or } 6.4 \text{ ft.}$$

$$Mr = 2 \times 5.75^2 \times 1200/6 = 13{,}200 \text{ in.-lb.}$$

[3]Span which will develop 1200 lb. per sq. in fibre stress and deflection of

$$\frac{\text{Span (in.)}}{360} = \frac{48 \times 7.75 \times 1{,}200{,}000}{5 \times 360 \times 1200 \times 2} = 103 \text{ in. or } 8.6 \text{ ft.}$$

$$Mr = 2 \times 7.75^2 \times 1200/6 = 24{,}000 \text{ in.-lb.}$$

[4]Span which will develop 1200 lb. per sq. in. fibre stress and deflection of

$$\frac{\text{Span (in.)}}{360} = \frac{48 \times 9.75 \times 1{,}200{,}000}{5 \times 360 \times 1200 \times 2} = 130 \text{ in. or } 10.8 \text{ ft.}$$

$$Mr = 2 \times 9.75^2 \times 1200/6 = 38{,}000 \text{ in.-lb.}$$

*Deflection in this case exceeds 1/360 span.

TABLE II. SPACING OF GIRTS IN FEET

Slab Thickness, ins.		3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
Weight, lbs. per sq. ft.[1]		112.5	125.0	137.5	150.0	162.5	175.0	187.5	200.0	212.5	225.0
Size of Girt, ins.	Span of Girt, ft.										
3×6	3	12.3	11.1	10.1	9.3	8.6	7.9	7.4	6.9	6.5	6.2
"	3.5	10.6	9.5	8.7	7.9	7.3	6.8	6.4	6.0	5.6	5.3
"	4	9.3	8.4	7.6	7.0	6.5	6.0	5.6	5.2	4.9	4.7
"	4.5	6.8	6.1	5.5	5.1	4.7	4.3	4.0	3.8	3.6	3.4
"	5	5.3	4.8	4.3	4.0	3.7	3.4	3.2	3.0	2.8	2.6
"	5.5	4.3	3.9	3.5	3.3	3.0	2.8	2.6	2.4	2.3	2.2
"	6	3.7	3.3	3.0	2.8	2.6	2.4	2.2	2.1	2.0	1.9
4×6	3	16.3	14.7	13.3	12.2	11.3	10.5	9.8	9.2	8.6	8.2
"	3.5	14.0	12.5	11.4	10.5	9.7	9.0	8.4	7.9	7.4	7.0
"	4	12.2	11.0	10.0	9.2	8.5	7.9	7.3	6.9	6.5	6.1
"	4.5	8.9	8.0	7.2	6.6	6.1	5.7	5.3	5.0	4.7	4.4
"	5	7.0	6.3	5.7	5.2	4.8	4.5	4.2	3.9	3.7	3.5
"	5.5	5.8	5.2	4.7	4.3	4.0	3.7	3.5	3.3	3.0	2.9
"	6	4.9	4.4	4.0	3.7	3.4	3.1	2.9	2.7	2.6	2.4

[1]Weight includes dead load of slab plus 75 lb. per sq. ft. live load.

[2]Span which will develop 1200 lb. per sq. in. fibre stress.

For 3 × 6-in. girts, $Mr = 35{,}000$ in.-lb. $= Mo \times 1.2$.

For 4 × 6-in. girts, $Mr = 33{,}000$ in.-lb. $= Mo \times 1.2$.

Table II gives the spacings of posts under the girts for various spans of joists and thicknesses of slabs. These tables were calculated for a 24-in. spacing of joists. The concentrated loads from the joists were used on a simple span in calculating the bending mo-

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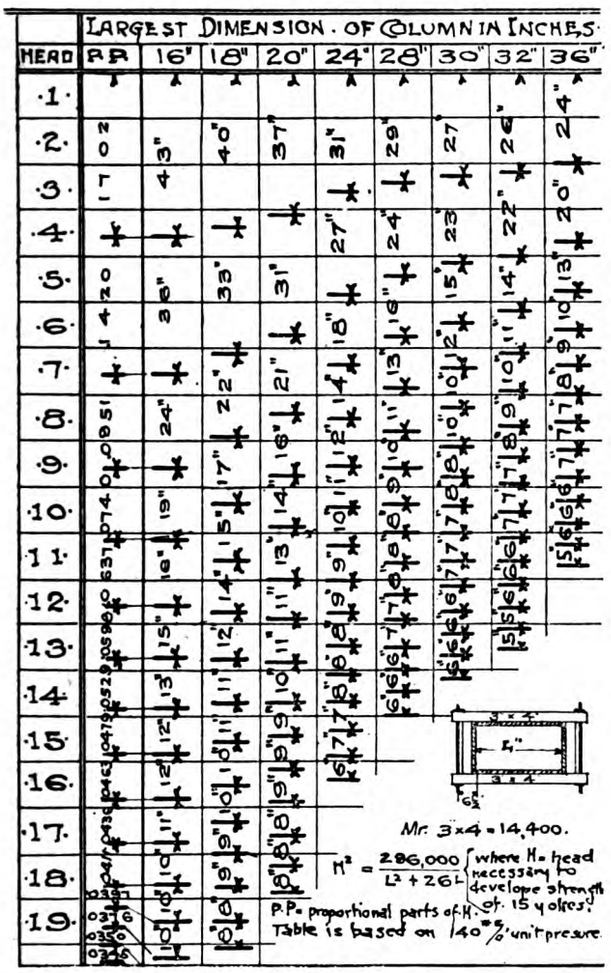
ment. The worst case, when one joist comes at mid-span, was used in this calculation.

It will be noticed that the full live load was also used in preparing this table. However, since the full live load will never get to the girt and the span of the girt is always continuous for at least two spans, the moment of resistance of the sticks has been multiplied by 1.2.

The load on the posts is next found. This load is usually far below its allowable load as a strut, but, as

TABLE III. SPACING OF WOODEN COLUMN YOKES

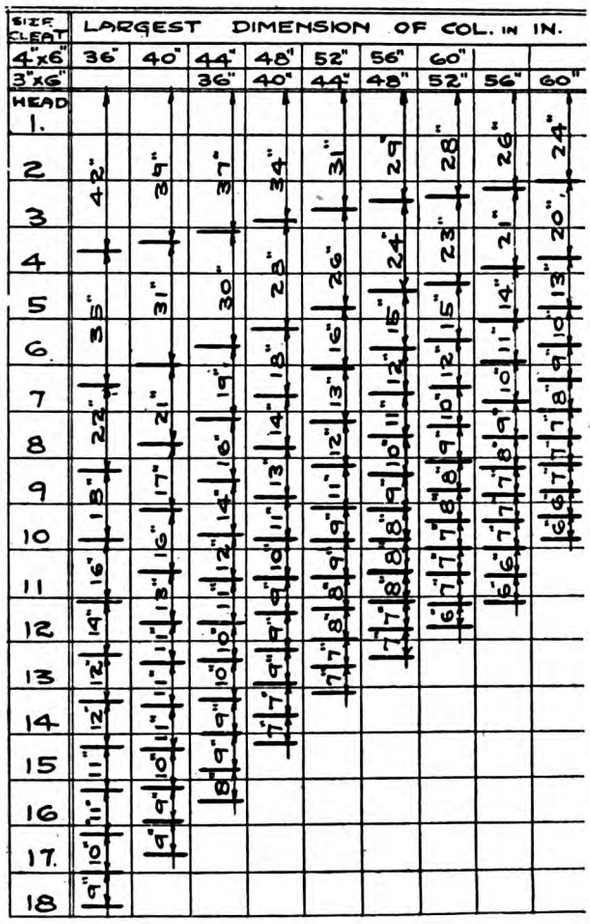


has been stated, the latter may cause an excessive crushing stress perpendicular to the grain in the girt at the top of the post. It is therefore well to play safe at this point, especially where granolithic finish is to be cast with the slab. A 'dish' in the finished floor is often caused by settlement in the panel due to this cause. A drop of ⅜ in. is not uncommon if soft wedges are used.

Deflection in the floor timbers themselves need cause little worry. As seen by the tables, fibre stress usually governs. When it is desirable to increase the spans given in the tables in order to make a better arrangement of centring with only a slight increase in fibre stress, it is well to compute the deflection.

Tables III and IV give the spacings of wooden-column yokes for a bolt-and-wedge scheme. A fibre stress of 1800 lb. per sq. in. has been allowed and the load on the cleats determined by using the concrete at 140 lb. per sq. ft. water-equivalent. The span of the yokes has been taken centre to centre of bolts, allowing 2½ in. for column sides, the thickness of the yokes, and 1 in. for wedging. One well known author on concrete work in a published table gives five 2 by 4-in. yokes on edge for a 30-in. column with 10-ft. head. I have seen a column fail under similar conditions when yoked with seven 3 by 4-in. I conclude, therefore, that in making such tables the span of the yoke must have

TABLE IV. SPACING OF COLUMN YOKES



been considered as the concrete column size and a low concrete pressure used in finding the load on the yokes. On our work we have used several styles of patented metal clamps and have always found that the manufacturer advocates a much greater spacing than we have found allowable on the job. In one case, we used eight adjustable steel clamps of a certain make on a 24 by 24-in. column 13 ft. 5 in. high. We noted considerable deflection in the clamps. We asked the makers for their recommendation for yoking a column of this size and height and their answer was "four or five clamps would be sufficient." We had practically the same experience with another make in regard to recommendation for spacing their clamps. I believe manufacturers would do well to make some study of

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actual conditions before putting their products on the market.

The deflection of the column sides between the yokes will never need attention except when large yokes are used. The limiting span for boards is shown in Fig. 1. In most cases when yokes are properly spaced for strength and for action on the bolts the spacing will be well within the limits for the boards.

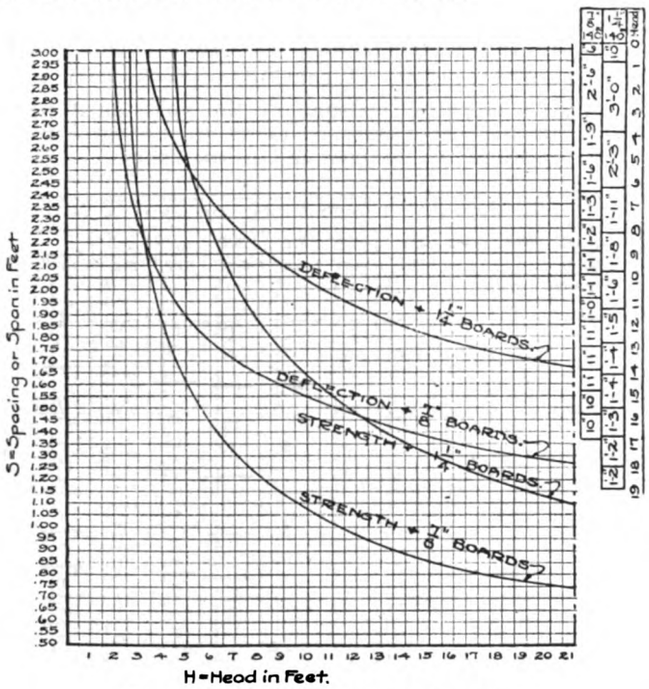

FIG. 1. SPACING OF HORIZONTAL STUDS.

Maximum fibre stress, 1200 lb. per sq. in. $M = 0.1\ wl$.

$$\text{Deflection} = \frac{3\,w\,l^3}{384\,E\,I}$$

A cheap method for centring a wall 6 ft. high and over is to use full-height vertical panels, heavy horizontal studs, heavy vertical liners or standards and large rods threaded at both ends, with suitable plate washers to give proper bearing for the load on the rod. By this scheme the stock can be stressed nearer to its allowable load and fewer ties used through the wall. There are so many unknowns entering into calculations for wall centring that any tables are of doubtful value. It should be noted that as a rule the head of concrete in a wall is limited by the height that can be cast by the placing outfit in an hour. Ordinary concrete begins to set in this time enough to lose much of its hydraulic effect. Using this height and 140 lb. per sq. ft. pressure will give safe results. When high heads occur it is economical to limit the height to which the concrete can be cast in order to use lighter forms. A system which requires a large number of rod or wire ties is decidedly uneconomical.

More important to the success of the job than the values used in the calculations are the methods employed in the drafting room in turning out drawings of forms accurately and speedily. The person in charge should be experienced in the different types of concrete building construction and should have men under him who are not simply 'picture' draftsmen, but men whose judgment of building work is reliable. With such an organization form details can be prepared in advance in the office, leaving the job superintendent free to work out the many other details attendant upon the beginning of the job. The carpenter foreman can also use his whole energy in directing the carpenter labor and the carpenters will need only to use their tools to assemble the panels made up in advance.

The first study and drawings to be made form a general assembly. Usually several different combinations of timbers and methods of assembling the panels are sketched up and compared as to cost.

A record of costs of the various units which go to make up the complete centring scheme is therefore necessary. Contractors who do not have such a record will find Taylor and Thompson's 'Concrete Costs' a valuable guide in this work.

Points to be remembered in this study are:

1. Joists and girts should be in as few lengths as possible to save time in sorting on the job.
2. Use stock sizes and lengths of lumber.
3. Keep number of panels and pieces to a minimum.
4. Provide easy stripping.
5. Allow clearance enough for slight inaccuracies in making up and erecting, swelling of panels, etc.
6. Panels should be a whole number of boards in width, if possible, for ease in making up.
7. Units to be as big as can be handled and joists used as panel cleats where possible.
8. Provide for re-use of panels.
9. Beams to be handled as trough units when the job is regular and units can be re-used.
10. Consider use of floor domes or inverted boxes when beams are close together. In this way beam sides and slab are erected, stripped, and moved as a unit. When either of the last two systems is used the beam sides should be given a slope to prevent hard stripping.
11. Provide for re-shoring if necessary.
12. Have bracing above men's heads.
13. When four beam haunches occur at a column consider making haunches as a unit similar to a column head in flat-slab construction.
14. Consideration of steel forms.

The general assembly shows how the various parts are to be put together, supported, tied, and braced to resist the concrete pressure and the weights coming upon the members. This drawing in its final shape can be made on tracing cloth with soft pencil. The dimension arrows, lettering and figures should be inked so that clear prints can be made to avoid errors in the field. These assemblies should be filed permanently for reference on future work. Fig. 2 shows a typical assembly for flat-slab construction.

When it is necessary to strip the floor centring for re-use before the concrete has been in place long enough to gain its full strength, provisions for proper support of the green slab must be made in the design of the floor forms. The safest and cheapest method of

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doing this, in my opinion, is to place boards between the floor panels and wedge posts up to a bearing under these boards before centring posts are knocked out. In this way the slab is never left unsupported as is the case when reposts are placed after all the centring is down. These boards should be placed according to a

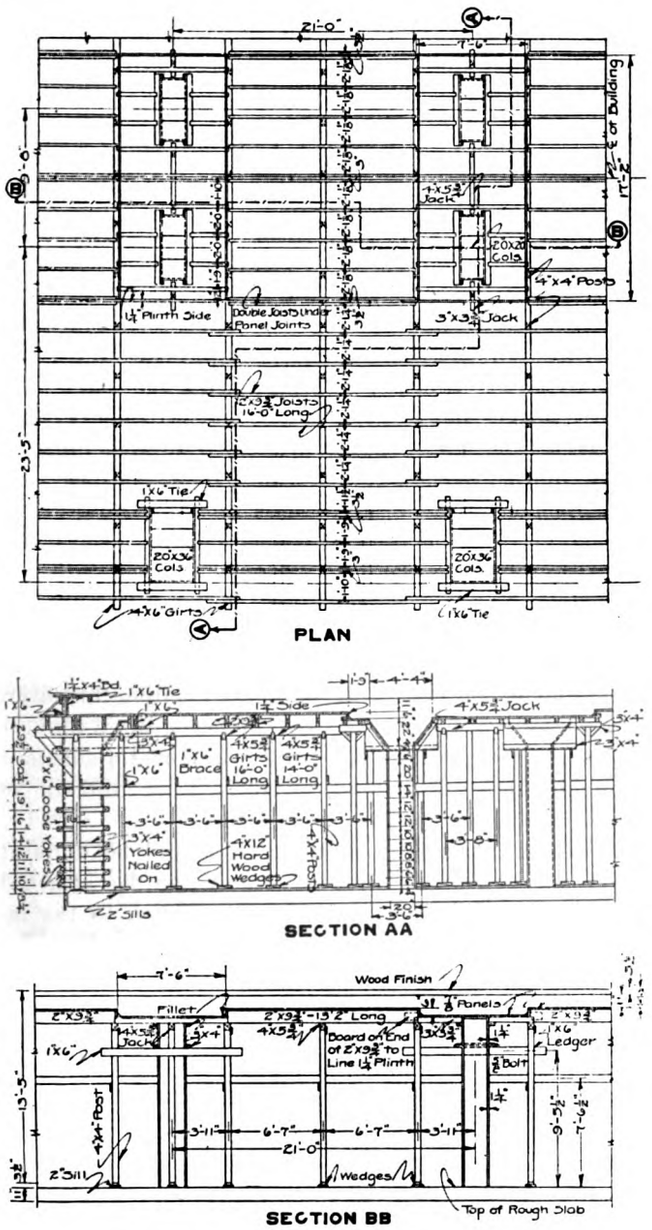

FIG. 2. TYPICAL ASSEMBLY OF FLOOR-CENTRING.

plan and so as to shorten the spans of the main reinforcing bands.

A system of symbols as follows is easily learned by the workmen and should be kept standard:

B—Beam side.
BB—Beam bottoms.
F—Floor slab panels.
P—Plinth forms.
H—Haunch forms.
C—Column sides.
W—Wall panels.

Thus B18 means beam side No. 18 and its position is shown on the key plan.

Where time allows and plans are complete, it is advantageous to get out one kind of panel at a time. In any case the first panels to be sent to the making-up mill should be the typical floor panels. These can be used economically in building foundation walls, etc., and in this way the job can get an extra use out of them.

The key plan mentioned above is really a diagram of the floor plan upon which is shown the position of the various form panels. This plan is the only one which the workmen consult in erecting the form work. It must, therefore, be complete and clear.

This plan can best be made by tracing the floor plan on cloth from a blue-print, indicating the beams and holes in the floor and the columns and walls in the story below. The lines should be heavily inked and the figures large enough and spaced so that the tracing can be photo-reduced to convenient size for the foremen to handle on the job. A big blue-print is inconvenient and fades in the strong sunlight. As a rule, to avoid misunderstandings, a key plan should be prepared for each floor in the building.

Materials. The materials to be used for the form work should be scheduled from the form drawings and not ordered by guess, as is so generally the custom. If complete form drawings for the job are available in time, it is economical to order even the boards for columns and beam forms to exact widths and lengths to make up the panels. This saves ripping and cutting off the boards in the job mill, where the saws are often taxed beyond their capacity at the beginning of the job getting out miscellaneous stock. It is always desirable to get the lumber in car-load lots because of the lower price. For this reason, on many jobs, in order to get the stock in time from mill shipment, it is necessary to prepare the schedule from the general assembly and typical details.

The ft. B.M. of $\frac{7}{8}$-in. 'roofers' for slab and wall panels can be taken off directly from the sq. ft. of floor and wall surface, adding at least 10% for waste and 25% for cleats. As these come in random lengths it is desirable to specify the length preferred, so as to get as big a percentage as possible of this length.

One and one-half inch boards for columns and beam sides and 2-in. plank for beam bottoms should be ordered S-4-S. Boards $7\frac{3}{4}$ in. and $5\frac{3}{4}$ in. wide after planing are the most useful widths for beam and column sides and can be ordered in random lengths, specifying again the lengths desired for as large a proportion as possible. The best length for the majority of columns and beam sides and the best width for beam bottoms can be easily taken from the plans by one familiar with form work. Stock for beam cleats and column yokes can be ordered rough and the quantity can be estimated closely from the assembly plan. Rough plank and timbers for staging and runways should always be included in the order.

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From the assembly of the columns and walls a schedule of the number and lengths of rods and fittings needed for tying the forms together can be made and the order placed early. It is safer and more economical to use rods threaded at both ends. The thread at one end can be short for a hand nut while the other end can be threaded to give any desired adjustment. A nut and washer can be set by a laborer at the proper point on the long thread so that the carpenters need only use the hand nut on the short thread. If a long thread on each end is desired, a nut can be turned up and loosened by a special socket-wrench operated like a carpenter's bit-stock.

The use of check nuts on a rod to give adjustment in length, depending upon a set screw for its grip, while convenient in some ways is not economical in the long run. The grip of the check nut is the weak point of the outfit. This makes it impossible to stress the rods to their working strength. If, however, a set screw is overlooked and not tightened at all a failure is liable to result. The worst that can happen when threaded rods are used is a crushing of the wood under the washer if the bolt is over-stressed. The washers used, of course, should not be the standard cast-iron variety, but should be steel plates of sufficient area to develop the strength of the rod when the washer is bearing on wood.

The possibility of using metal forms must be considered when planning the form work for any concrete structure. Where it is possible to use the same units many times without remodeling, or by making adjustments easily provided for in the metal forms, the latter are usually an economy. On sewers, pipe-lines, subways, straight wall work, etc., they can usually be used to advantage. In building work the use of metal forms, except for round columns and column heads in flat-slab construction, is of doubtful economy. It is usually impossible to get enough uses out of the metal forms on one building to make the first cost, even on lease, compare favorably with wood. Then, again, the building must be designed for the standard form units or else there is the expense of buying special units which are of no use after the building is done.

Our company has recently used one well-known make of sheet-metal forms on the exterior walls of a group of five buildings having a total of 267,000 sq. ft. of contact surface. These wall surfaces were at first thought ideally adapted to metal forms, but when the elevations were laid out and the task of fitting standard units to them begun, many obstacles were encountered on account of irregularities. Many special panels had to be purchased and a great deal of wood used for the fitting. By this office study many problems were encountered and solutions found long in advance of erection, thus saving time and expense on the job. On this job the forms were used an average of 13½ times at a labor cost of 9.23c. per sq. ft. for making, erecting, and stripping. The total cost, including material and plant, was 12.93c. per sq. ft. These figures include office expense of the job. This work was done by an organization enthusiastic over the use of steel forms. The costs are as low as can be expected on general work.

One bad feature we found with the particular form we used was the cost of purchasing extra wedges and keys. Of a total cost of 2.7c. for material, 0.5c. was for extra keys. These were loose parts easily lost. There are makes of steel forms which do not have this disadvantage and they might prove less expensive. The steel forms on these buildings produced a good exterior, true to line, and required less rubbing down after the forms were stripped than is usually the case with wooden forms.

There are several schemes of patent adjustable metal centring and column-yokes on the market which have merit for particular cases and should be investigated when considering form material. Material of this kind, which can be rented, is attractive to the contractor who dislikes to fill up his plant yard with equipment not always usable and to pay freight charges when lumber can be picked up locally, both quickly and cheaply.

Corrugated sheet-metal for slab forms can be used economically on some buildings, especially those of the flat-slab type. The sheets are laid over the wooden joists, lapping the metal at the ends and sides. These sheets can be re-used many times and re-corrugated on the job. When unfit for forms the sheets can still be used for concrete chutes and as siding for temporary buildings on the job. The corrugated ceiling, however, is objectionable to some owners. When a large number of inserts need to be placed, the use of metal sheets is of doubtful economy because it is more difficult to attach the inserts to the metal forms.

As much assembling as possible should be done at the bench. Rangers for wall beams can be attached and ledgers to support joists can be nailed to the interior-beam side-cleats at the proper depth. When inserts need to be placed in the sides of beams, the holes for the bolts to hold them can be located on the details and the holes bored at the mill. The groove strip for steel sash and also the corner fillet can be put on the column sides and beam bottoms. Bevel key-strips for walls should also be nailed lightly to the panels when necessary. Heavy cleats for big wall columns should be cut and bored, but not attached to the panels. The panel can be cleated with 1¼-in. boards, and is thus made much lighter and easier to handle in erecting. Clean-outs at the bottom on two opposite sides of all columns should be made at the mill. Reduction strips should be nailed at the edge of all panels which reduce in size when re-used. All small pieces liable to get lost or used for other purposes can be dipped in red paint so that their small size will be respected by the carpenters when looking for loose boards.

Much waste in making up ⅞-in. panels can be prevented if the floor is laid out so as to make the majority of the panels a whole number of boards wide. Roofers come 5⅜ in. to 5½ in. wide, and it is an easy matter to plan the panels to come, say, seven or eight boards

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wide, which means no waste in ripping one board to make the width. The length should be planned as near stock lengths as possible. Panels made of spliced boards are expensive to make and easily broken.

It is usually not economical in labor to make up panels from lumber which has already been in contact with concrete several times. If, however, panels are in good condition they can be cleaned and repaired at a considerable saving, both in labor and material. As an example, 13,562 sq. ft. of ⅞-in. floor panels was cleaned, repaired, cut to a new length, oiled, and piled; 6560 sq. ft. of 1¼-in. column sides was cleaned, repaired, oiled, and piled; 1250 sq. ft. of column heads was cleaned, repaired, oiled, and piled, at a total cost of $99.25, or a unit labor cost of $0.00466. The estimated labor cost of making the above forms from new stock, using unit costs obtained on the same work, was $178.20, or a saving of over 40% in labor, besides a big saving in material. Old 1¼-in. panels can be knocked to pieces, the boards cleaned and piled for about $3 per 1000 ft. B.M. Large quantities of typical forms can be made from these boards at a slight increase in labor cost over using new stock. The lumber saving is considerable. The quantity made must be large to allow a thorough routing of the old stock through the mill.

The cleat spacing for the various kinds of panels should be kept uniform so that the strips on the benches, for spacing the cleats, will not need to be moved for every set of panels. For beam sides 2 by 3-in. cleats, flat, can be used on panels up to 30 in. deep; 2 by 4-in., flat, up to 42 in.; and 3 by 4-in., on edge, above 42 in. deep. Nails should be specified about as follows:

No.	Size	Width of board
3	10d	6¾ and 7¾ in.
2	10d	2¾ to 5¾ in.
1	10d	Less than 2¾ in.
..	12d	In 3×4-in. cleats
..	8d coated and clinch ends	In ⅞-in. boards

Wire nails should be used for form work because of ease in driving and drawing. The holding power is also sufficient. Double-headed nails should be used in securing all boards which have to be loosened before stripping.

General Notes on Form Work. Projecting belt courses break up the continuity of the exterior column forms and should be avoided except on high buildings. Heavy overhanging cornices, consoles, and brackets needed at the top of a tall building can be made more cheaply of sheet metal and attached to a plain concrete cornice beam by means of steel brackets. The effect is just as pleasing as if expensive forms are made and the concrete members cast.

The number of different sizes of beams, columns, and thickness of slabs should be kept a minimum. This means fewer different kinds of units. The panels can be made and handled more cheaply, to say nothing of the time saved in designing. The biggest item of expense, however, is that of remaking beam and column forms and patching floor forms when changes occur in the size of the members on different floors. It may be nice to know, for instance, that an 18 by 18-in. column is sufficient to carry the load, but it is better to know that a 20 by 20-in. column, as used in the story below, is the size to use ordinarily. This saves remaking the column sides and patching the beam and slab forms. In most cases concrete is cheaper than altering forms.

Stock sizes of lumber should be kept in mind when dimensioning the concrete members. For example, projections should be made 1¼ and 1¾ in. instead of 1 and 2 in., since dressed stock comes nearer the former sizes. Beams can be made 11¾ in. wide instead of 12 in. Thus one 12-in. plank can be used without needing a ¼-in. strip tacked to the edge. Points such as these, thought out in the designing room, mean a cheaper building.

It is economical on jobs where speed is not required to place concrete with light equipment and slowly. Lighter forms can then be used because the live load is greatly reduced when tracks and big cars do not need to be supported by the forms.

STATISTICS OF PAVEMENT CONSTRUCTED IN THE UNITED STATES DURING 1914 AND 1915

The following table taken from *Better Roads and Streets*, was prepared by F. W. Patterson of the Cleveland-Trinidad Paving Co., Cleveland, Ohio, and is believed to include at least 90% of the pavement laid during that period.

Types of pavement	1914 sq. yds.	1915 sq. yds.
Sheet asphalt	7,834,187	9,928,714
Bitulithic	3,218,943	3,519,542
Bituminous concrete	3,302,721	4,956,892
Asphalt block	450,421	731,676
Brick	6,392,559	6,078,469
Wood block	1,722,720	1,093,435
Concrete	4,460,302	5,606,799
Concrete, bituminous top	933,212	1,057,016

Costs of tile-drains and open ditches on the Yakima-Sunnyside project of the U. S. Reclamation Service, are given in the *Reclamation Record*, by R. K. Tiffany, project manager. The area in process of reclamation on which ditches have been completed is 26,848 acres. The cost of the ditches constructed within this area is $360,537.14, or an average of $13.46 per acre. The contract prices for open ditches range from $0.15 to $0.20 per cu. yd. The prices for covered tile-drains were as follows: 6-in., $0.45 to $0.50 per lin. ft.; 8-in., $0.55 to $0.70; 10-in., $0.55 to $0.72; 12-in., $0.70 to $0.85; 15-in., $0.98 to $1; 18-in., $1.17. Drainage systems for 13,689 acres more, requiring 40 miles of drains, are now under way, the cost of which will be approximately $197,525.40. There will be 24 miles of open ditches, on which the contract prices are $0.11 and $0.115 per cu. yd. For the 16 miles of tile-drains, the contract prices are as follows: 6-in., $0.40 to $0.43; 8-in., $0.50 and $0.51, 10-in., $0.60 and $0.61; 12-in., $0.69 and $0.70; 15-in., $0.85; 18-in., $1.05 and $1.25; 20-in., $1.25.

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Bids on Sacramento River By-Pass Weir

Following is a summary of the bids received May 23 for the construction of the Sacramento River by-pass weir. Contract was awarded to Teichert & Ambrose.

(1) Teichert & Ambrose, Sacramento.
(2) McLeran & Peterson, San Francisco.
(3) Howard S. Williams, San Francisco.
(4) Tibbitts Pacific Co., San Francisco.
(5) Ross Construction Co., Sacramento.
(6) Clarke & Henery Construction Co., Sacramento.
(7) James Kennedy, Sacramento.
(8) Sound Eng. & Con. Co., San Francisco.
(9) Blake Bros. Co., San Francisco.

(A) Excavation for abutments, piers, and weir to be placed in railroad approach, 42,000 cu. yd. in all, per cu. yd.

(B) Embankment borrowed for temporary railroad track and approach to weir, 50,000 cu. yd. in all, per cu. yd.

(C) Reinforced concrete pier piles, per lin. ft.

(D) Reinforced concrete pier piles, cement furnished, per lin. ft.

(E) Reinforced concrete sheet piles, per lin. ft.

(F) Reinforced concrete sheet piles, cement furnished, per lin. ft.

(G) Reinforced concrete abutments, wings, piers, footings, 6400 cu. yd., total.

(H) Reinforced concrete abutments, etc., cement furnished.

(I) Reinforced concrete weir, apron, water-cushion, guide-walls, etc., 8300 cu. yd. in all, total.

(J) Reinforced concrete weir, etc., cement furnished.

(K) Reinforced concrete highway bridge, paving, and conduits, 2050 cu. yd. in all, total.

(L) Reinforced concrete highway bridge, etc., cement furnished.

(M) Forty-eight 42-ft. spans, ties, guard-rails, etc.

(N) Needles, needle-beams. cables, hinges, shoulders, timbers, bolts, etc.

(O) Floats, rods, and triggers, each.

(P) Removing and storing present railroad track, maintaining temporary track, furnishing ballast, replacing and ballasting approaches.

(Q) Furnishing barge with movable gates.

(R) Overhead highway crossing over temporary track.

(S) New anchors, removing and maintaining anchors.

(T) 1:3:6 concrete, per cu. yd.

(U) 1:3:6 concrete, per cu. yd., exclusive of cement.

(V) 1:2½:5 concrete, per cu. yd.

(W) 1:2½:5 concrete, per cu. yd., exclusive of cement.

(X) 1:2:4 concrete, per cu. yd.

(Y) 1:2:4 concrete, per cu. yd., exclusive of cement.

(Z) Structural steel, per lb.

(AA) Weir timber, per M.B.M.

(BB) Hinges, per set.

On proposition B, which was for the construction of the weir complete, the bids were as follows:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(A)	$0.26	$0.25	$0.183	$0.38	$0.42	$0.26	$0.50	$0.585	$0.275
(B)	0.22	0.25	0.233	0.38	0.30	0.26	0.50	0.645	0.275
(C)	1.02	1.00	1.178	1.16	1.25	1.20	1.32	1.235	1.68
(D)	0.84	0.90	1.06	1.04	1.13	1.05	1.195	1.10	1.55
(E)	1.22	1.15	1.219	1.44	1.40	1.30	1.45	1.35	2.10
(F)	1.04	1.02	1.096	1.295	1.25	1.15	1.315	1.225	2.00
(G)	46,800	55,000	54,344	51,600	62,750	56,600	55,267	59,244	74,000
(H)	35,800	42,000	41,159	39,100	50,000	41,100	42,375	45,044	60,000
(I)	78,000	75,600	77,880	74,600	86,000	80,000	78,370	84,826	93,000
(J)	59,000	56,000	58,510	57,500	68,000	56,000	58,498	65,426	74,000
(K)	44,000	47,000	50,545	44,750	55,000	46,500	57,995	53,589	50,000
(L)	38,000	41,000	44,440	39,600	50,000	37,000	57,625	47,289	47,000
(M)	62,000	61,000	59,522	66,300	63,000	68,000	79,159	52,689	64,000
(N)	10,600	10,000	12,500	7,794	8,500	7,000	16,947	12,400	9,000
(O)	40	50	40	155	40	35	170	25	28
(P)	12,000	15,000	17,400	11;000	12,000	16,000	14,866	27,545	14,000
(Q)	2,500	2,000	1,800	2,100	2,000	1,000	1,724	1,981	1,400
(R)	350	450	1,200	1,459	500	1,000	600	700	900
(S)	300	500	900	750	200	250	100	290	1,000
(T)	6.00	10.00	10.00	8.00	20.00	8.70	14.00	8.60	12.00
(U)	4.00	8.00	7.85	6.00	18.00	6.20	12.00	6.50	10.00
(V)	6.50	10.50	11.00	8.90	20.00	9.15	14.00	10.10	13.00
(W)	4.00	8.00	8.50	6.50	18.00	6.30	11.60	7.65	11.00
(X)	10.00	11.00	21.60	20.00	22.00	17.20	14.00	22.50	24.00
(Y)	7.00	8.00	18.10	17.00	20.00	13.20	11.00	19.50	21.00
(Z)	0.05	0.055	0.045	0.06	0.07	0.06	0.10	0.045	0.06
(AA)	50.00	45.00	40.00	25.00	35.00	50.00	50.00	45.00	45.00
(BB)	2.50	5.00	2.00	1.50	2.00	1.00	7.00	1.65	2.00

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Welding Gas-Mains by the Oxy-Acetylene Method*

The oxy-acetylene process of welding as applied to gas-mains was developed primarily as a means of combating the heavy leakage, sometimes as much as 25%, in high-pressure lines. The Pacific Gas & Electric Co. produces about 20,000,000 cu. ft. of gas per day at San Francisco. A transmission loss of 25% or 5,000,000 cu. ft. represents a financial loss of about $3000 per day. Incidentally the oxy-acetylene process reduces the first cost of making joints considerably and eliminates maintenance cost almost entirely.

In San Francisco, the Pacific Gas & Electric Co. has a 16-in. main running from the Potrero through the heart of the city to the North Beach district. It was laid a short time before the company began to investigate welding and the couplings are made mainly with rubber gaskets. The cost was about $4 per joint. These gaskets seldom last as long as four or five years. When they are worn out it is necessary to dig up the street, shut off the supply of gas for the time being and renew the gaskets. With the welded joint, the cost of a joint is $2.35 and there is no maintenance cost.

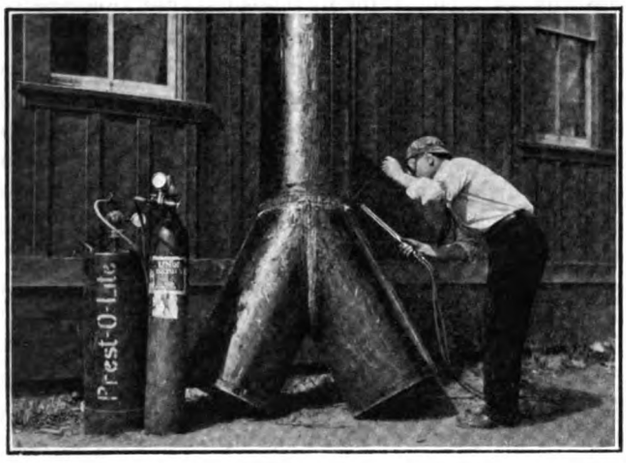

FIG. 1. MAKING JOINT IN 24-IN. PIPE.

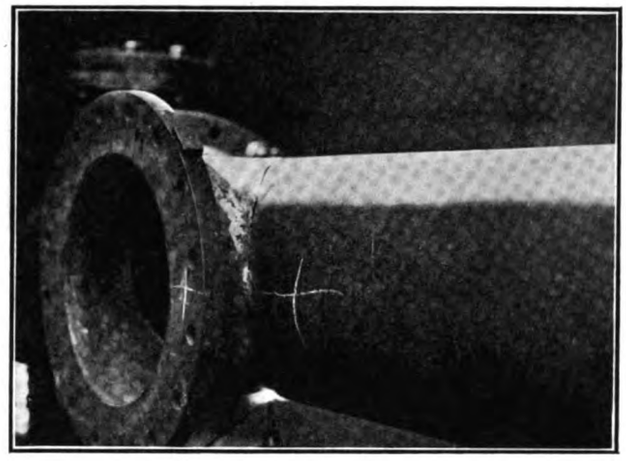

FIG. 2. TORCH WORKING ON 16-IN. PIPE.

Acetylene may be obtained from either the Prest-O-Lite Co. or the Commercial Acetylene Co. It is supplied in cylinders under pressure containing 300 cu. ft. of free gas. The cost in San Francisco is 1¾c. per cu. ft. The gas can also be generated on the job, at a cost of ⅞c. at the generator. There is, however, considerable additional expense in bringing the gas to the joint itself, and it will be found cheaper and more convenient to buy the gas in cylinders. Oxygen is supplied in cylinders containing 100 cu. ft. and 250 cu. ft. of free gas. The smaller size will usually be found more convenient for field work.

Reducing governors, gauges showing the contents and pressures, the hose, and the torch complete the outfit, which can be mounted complete on a small truck.

The pipe is supplied in 40-ft. lengths. The 2, 3, and 4-in. pipe is welded along the side of the trench, then picked up bodily and thrown into the trench. The 8 to 16-in. pipe is welded on timbers placed over the trench. The timbers are then removed and the pipe allowed to drop into the trench. When the welding method was first introduced, the pipe was lowered into the trench carefully, but it was found to be better to drop it in, as this would show up any possible leaks and cracks before the trench was filled. On the rare occasions when the pipe does show weakness after such treatment, it is usually in the body of the pipe and not in the weld. The ends of the pipe are cut at an angle of 45° so that when placed together they form a deep groove. The welding is then simply a matter of fusing both ends of the pipe and the Norway iron welding-wire. Expansion and contraction are overcome by laying the pipe in a slightly crooked line from side to side of the trench. After being welded and thrown into the trench, the pipe is subjected to a pressure of 250 lb. per sq. in. for two or three days without appreciable leakage or drop in pressure. Bends are made by cutting the pipe at an angle and then welding it, both cutting and welding being done by the oxy-acetylene torch. The cost for a 16-in. pipe is about $5 against $90 to $100 for the old-style machine-bend.

This method of making bends is particularly useful when it comes to dealing with interferences. These are especially troublesome in San Francisco, because there have been five different gas companies. Hitherto it was necessary, when making an extension, to dig up the

*Abstract of paper presented at the meeting of the San Francisco section of the American Society of Mechanical Engineers, April 20, 1916, by D. E. Keppelmann, General Superintendent of Gas Distribution, Pacific Gas & Electric Co., San Francisco.

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streets at intersections, prepare plans of all interferences and wait for special castings to be made. Now the pipe may be cut and welded to fit around the other pipes at a great saving in both time and money.

The oxy-acetylene process can also be used for fitting the water, gas, and steam-pipes in buildings, at a saving of probably 60 or 70% over the present methods, besides the advantage of an absolutely permanent job. 'Drips' on main transmission lines can be constructed by welding at a great saving in cost over the old method.

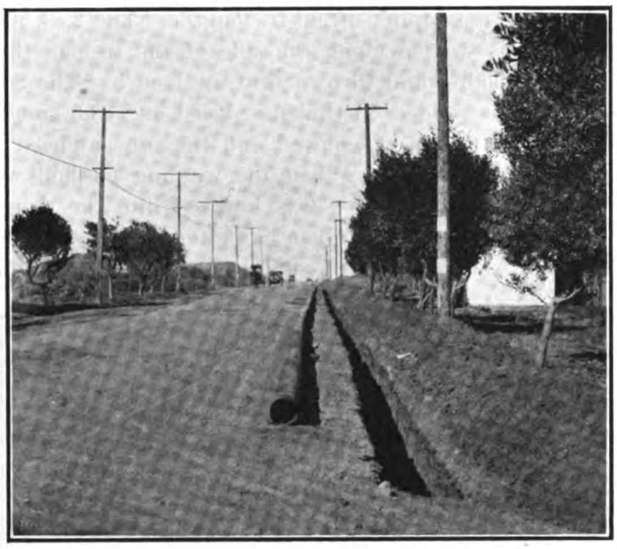

FIG. 3. LINE OF 8-IN. PIPE READY TO BE THROWN INTO TRENCH.

Fig. 1 shows a weld made in 24-in. pipe, $\frac{1}{8}$ in. thick, for a water company operating in Alaska. This company has much trouble in the maintenance of its lines, largely because of the delay and the heavy cost involved in having special fittings made and shipped so great a distance. They are now having a welding outfit shipped to them, and expect to weld their own fittings in the future.

The welded joint is so satisfactory as regards prevention of leakage that it is the custom of the company to cut off riveted joints and weld them instead. Another great advantage of the use of welding is that the junk metal, which was formerly thrown on the scrap-pile can now be worked up into various small fittings and other useful articles. In fact it is possible to dispense with the scrap-pile entirely, saving several thousand dollars a year.

Costs of street cleaning and of hauling ashes in Milwaukee are given in *Better Roads and Streets.* The average cost per 1000 sq. yd. with a horse-drawn squeegee, 25.5c.; with a motor-driven squeegee, 16.5c.; with a horse-drawn flusher, 37.1c.; with a horse-drawn sprinkler making two trips over the area, 13.2c.; with a horse-drawn rotary broom, 38.8c.; with a motor-drawn pick-up sweeper, 21.4c. Hauling ashes with a 3-yd. dump-wagon cost 17.5c. per yard-mile; with 5-yd. dump-wagon cost 11.8c. per yard-mile; and with an 8-yd. dump automobile-truck, 6.3 cents.

REDUCTION IN WATER CONSUMPTION AT IMPERIAL, CALIFORNIA, DUE TO INTRODUCTION OF METERS.

By GEORGE NELSON*

Like most of the cities in the Imperial valley, Imperial obtains its water supply from one of the large irrigating canals taking water from the Colorado river. The first system was constructed in 1902 by a subsidiary company connected with the concern that was selling the town-lots. This consisted of a 6-in. duplex piston pump belt-connected to a 25 hp. electric motor, which pumped the water from settling basins into two 20,000-gallon corrugated-iron tanks. The distribution system consisted of about one mile of 6-in. and 8-in. wood-stave mains with laterals of 2-in. iron pipe. This system was operated until 1911, when it was taken over by the city and connected with the municipal system.

The municipal system was constructed in the latter part of 1909, the contractor being George A. Rodgers of Los Angeles. The water in the canal that furnishes the supply contains a large proportion of silt, so that it is first turned into settling-basins. One of these is lined with concrete, a 1:2:4 mixture being used, and the other is unlined at present. They are both 90 by 370 ft. on the bottom and from 5 to $6\frac{1}{2}$ ft. deep. The side slopes are 1:1 in the concrete lined, and $1\frac{1}{2}$:1 in the unlined. Each basin holds approximately 1,500,000 gallons. The silt is flushed to a sump, from which it is removed by a 4-in. Krogh dredge pump. The silt is allowed to flow over low places near the plant.

A 10-in. pipe connects the settling-basin with the pumping-sump, the intake of the pipe being so arranged that it is kept at a depth of one foot below the water-surface. From the pumping-sump the water is raised 112 ft. to a 100,000-gallon steel tank. There are two 6-in. two-stage Risdon-Sulzer pumps with a capacity of 500 gallons per minute, the second pump being used only in case of breakdowns or during fires. The distribution system consists of 19,362 ft. of 4 to 10-in. cast-iron pipe, and 4360 ft. of 2-in. wrought-iron pipe.

In July 1914 the water consumption was about 750,000 gallons per day. Realizing that this amount was unnecessarily large, water superintendent T. E. Manning succeeded in obtaining permission from the city trustees to commence metering the system. At present there are meters on 350 services, or 95% of the entire number. In spite of an increase in the number of services the average consumption during July 1915 was only 400,000 gallons per day, or a little more than half of the amount pumped the year before. The saving in cost of power amounts to about $45 per month. Trident $\frac{5}{8}$-in. and $\frac{3}{4}$-in. meters are used. The strainer is removed on account of the large proportion of silt even after the water has passed through the settling-basins. There is also some accumulation of moss. Meters are cleaned when it becomes necessary. Some of them have gone for over a year without cleaning being required.

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*Civil engineer, Hearst Bdg., San Francisco.

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The California Gasoline Industry*

By W. R. HAMILTON†

The knowledge of the existence of petroleum in southern California dates back to the days of the missions. The presence of asphaltum and semi-solid bitumen was reported at Santa Barbara in 1792, but no serious attempt was made to develop oil until Professor Silliman's optimistic report in 1865 started California's first oil boom. Wells were drilled in many counties of the State, but the equipment was unsuitable and the drilling difficult and no production was obtained except in Ventura county. Even there production was of little importance commercially, and not until the early '80s did it become sufficient to again attract attention. In 1888 the production for the State had reached a total of about 700,000 bbl. per year, practically all light oil produced in Ventura county, Pico canyon, Los Angeles county, and in the Puente hills. The production of petroleum attained the dignity of an industry in 1895 when the Los Angeles City and Coalinga fields were discovered. The subsequent development has been remarkable, and in 20 years the production has increased from 1,000,000 to 100,000,000 bbl. per year.

The refining industry has kept pace with the production of oil. The Pacific Coast Oil Co., the predecessor of the Standard Oil Co. of California, was the virtual pioneer refining company of the State, having built a refinery at Alameda about 1880. When purchased by the Standard Oil Co. about 1902, it was dismantled and the refinery at Point Richmond was built. The Richmond refinery is now one of the largest in the world, having a capacity in excess of 60,000 bbl. per day. A small refinery was built by the Union Oil Co. at Santa Paula in the early days of the industry and later many asphalt refineries were in operation in southern California. The Pacific Coast Oil Co. was then, as has been its successor, the Standard Oil Co. of California, the principal refiner and marketer of light products, the most valuable of which was kerosene.

Before the opening of the twentieth century, gasoline of excellent quality was produced, though it was always a drug on the market and was produced for the simple reason that its presence rendered the flash and fire tests of the kerosene too low. The user of kerosene at the present time obtains a safer and better oil than he might receive had not the value of gasoline been increased by the increased demand.

The phenomenal development of the California oil fields in the earlier years of the twentieth century was principally in oils of such heavy gravity that they were used in the crude state for fuel. During the last six years, which has included the 'gusher' period of the Midway fields, the production of refinable oils has increased greatly, while, strange as it may seem, the production of heavy non-refinable oils has decreased. During this period, from the beginning of the present century, the introduction and perfection of the automobile has changed gasoline from a despised and troublesome by-product to the most valuable and important product of the crude oil. The production of light oils did not keep pace with the demand for gasoline and as a consequence the price of gasoline increased from about 16c. in 1904 to 25c. in 1910. The shortage was reflected in the prices paid for light crude. In the feverish development period which resulted, an enormous increase was shown in its production, until in 1914 the output of light oils capable of being refined was in the neighborhood of 50,000,000 bbl. The resulting gasoline being considerably in excess of the demand, prices began to fall in 1911 and, aided by importations of gasoline from the Dutch East Indies, the price rapidly declined to a low level of 11c. per gallon in the summer of 1915.

The late increase in the price of gasoline is ascribed to the following causes:

1. Decreased production of refinable oil. The decrease probably amounted to about 6,000,000 bbl. in 1915.
2. Steadily increasing consumption.
3. Discontinuance of gasoline imports due to increased European demand.
4. Heavy exports due to European war.

All of these conditions may reasonably be expected to exist for some months to come. There is no reason to expect a reduction in the rate of consumption. The acceleration of the growth of the automobile industry shows no decrease and, with the rapidly increasing mileage of improved highways in California, an increase rather than a decrease may be looked for. It is unlikely that gasoline will be imported from the Dutch East Indies so long as it is possible to deliver it to the European market. The serious shortage of oil in the Eastern and Mid-Continent fields, which developed in 1915, and which resulted in cargoes of gasoline being shipped from California to Europe, does not as yet show evidence of alleviation, and the only prospect of production reaching consumption seems to rest in the discovery of another phenomenal field such as Cushing, Oklahoma. Unless the Eastern fields can increase their production it is to be expected that further exports will be made from California.

There is no doubt that, unless the year 1916 shows a considerable increase in the production of gasoline, which is unlikely, or unless a satisfactory substitute for use in

*Paper to be presented at the Arizona meeting of the American Institute of Mining Engineers, September 1916.

†Consulting geologist, Insurance Exchange Bdg., San Francisco.

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motor vehicles is provided, we face a serious gasoline shortage on the Pacific Coast.

Increased production of gasoline may come from one of the following causes:

1. Increased production of light oil.
2. Increased production of casing-head gasoline.
3. Lowering the grade of market gasoline.
4. Innovations in refining methods, such as the Rittman, Burton, Snelling, Cosden, McAfee, Wells, Kelsey and Washburn processes.

1. There does not appear to be more than temporary relief to be looked for in increased oil production. All the principal fields have apparently nearly reached the height of their productiveness and while some may increase, the decline of the others will probably outweigh their gain. Unless I am greatly mistaken, the year 1914 will long remain the banner year of California's oil production.

2. The production of casing-head gasoline, which is based on the recovery of the lighter hydrocarbons usually lost in oil production by volatilization, is of recent development. At present it accounts for less than 10% of the gasoline marketed in the State. Owing to the low price in 1913 and 1914, the increase of gasoline produced in the gas industry has been retarded. Several new plants, however, are now under construction. The gas amenable to such treatment is limited, and it is unlikely that the new production of gasoline from this source can be expected to have any marked effect.

3. By lowering the grade is meant including higher boiling-point fractions in the gasoline as the cut is made at the refinery. Before the demand for gasoline was great, the gravity of marketed gasoline was about 65° and even as light as 72° Baumé. The boiling-point of the 'last over' or the end-point of the distillation of such a gasoline was little higher than 200° F. With diminished supply and increased demand, the gravity has been gradually decreased until the present standard is from 59° to 61° Baumé with an end-point from 320° to 380° F. The cut in the refinery distillation is, therefore, widened and the production of marketable gasoline produced is thereby increased. If no other way is found to supply the demand, this cut can be widened still further while continuing to furnish the motorist a satisfactory fuel. The production can probably be increased from 30 to 50% in this way.

4. The processes mentioned show considerable promise. They depend for their success upon being able to break up the molecule of high boiling-point hydrocarbons into lower boiling-point molecules. The processes may be divided into two main classes, those which depend upon excessive heat or pressure or both and those which depend upon a catalytic agent.

The most notable of the former are the Burton and Rittman processes. The Burton process, which was patented by William M. Burton in 1912, is controlled by the Standard Oil Co. After many difficulties have been overcome and much money expended in experimental work, this process has been made successful and is now being installed in many Standard Oil refineries. Much difficulty was first encountered in producing an article that was of good color and odor. This has been overcome and the Burton process now gives the Standard Oil Co. an important advantage over its rivals. So far, it has not been successfully applied to California asphaltic oils where the presence of a large proportion of unsaturated hydrocarbons results in difficulties not experienced with the oils from the Eastern fields.

The Rittman process is the result of the research work of W. F. Rittman of the U. S. Bureau of Mines. The process has already been successfully applied to the commercial manufacture of toluene and benzene. It differs from the Burton, Snelling, Cosden, Washburn and Wells processes, in that the action takes place after the liquid has been vaporized. By subjecting the vapor to pressure and heat, a re-arrangement of the molecules is effected, liberating carbon which is removed from the plant without difficulty. The process shows much promise and, while much remains to be done before it can be considered a commercial success, it has created a profound impression among refiners. Under the rulings of the Government, a Federal employee may not profit in this country from any discoveries or inventions during his connection with the Government. The foreign rights will be controlled by Dr. Rittman. The Government proposes to allow anyone to use the process under license, and it is probable that the increased value of gasoline and the handicap confronting the 'independent' refiners on account of the Standard's control of the Burton process will result in an early attempt to perfect the process. It has been perfected as far as is possible in the laboratory stage and its future depends upon the results of its application on a practical scale.

Of the processes making use of a catalytic agent, the McAfee process, which is controlled by the Gulf Refining Co., is the most promising. The catalytic agent is aluminum sulphate, and results from experimental work are said to be excellent. However, this process, like the Burton, will probably be unavailable to other companies.

The future has generally cared for itself and will undoubtedly do so in the gasoline industry. While we shall probably have a gasoline shortage extending well into 1916 and perhaps into the early part of 1917, the result will be redoubled interest in the subject of perfecting such ideas as have been brought to light in the experimental work done in the above-mentioned processes. The research work of Dr. Rittman and other able scientists who are working on the problem, bids fair to develop a practice which will revolutionize the refining industry.

Excavated material for aggregate is being used in the concrete lining of an eight-mile water-works tunnel now being driven in Chicago. A screening machine and belt-conveyor delivers all material under 4-in. diam. to a hopper above the mixer. The concrete is 'shot' to the forms by compressed air for distances up to 800 ft.

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Proposed Elimination of Drawbridges at Oakland Estuary

The two swing-drawbridges over the Oakland estuary, a highway and street-car bridge at Webster street and a railroad bridge at Harrison street, are at once a serious impediment to vessels bound for the Oakland inner harbor and a source of delay to land traffic. Since the bridges have a clearance of only seven or eight feet above high water, it is necessary to open them for all but the smallest boats. The two bridges are only one block apart and each has a centre pier protected by pile dolphins in the middle of the stream. When the two draw-spans are open, their ends are but a short distance apart. The clear width of the channel at the openings is approximately 150 ft. To pass the bridges, a ship must navigate a channel over 800 ft. long and only 150 ft. wide. The tidal current is strong and there is considerable difficulty in towing ships against it, particularly while waiting for the draws to open.

In January 1912 the authorities of Alameda county and of the cities of Oakland and Alameda commissioned P. A. Haviland, county surveyor of Alameda county, to prepare a report on the construction of a subway to eliminate the two bridges. This report was rendered in March 1913. Three plans for subway construction are discussed.

Plan A provides for five separate tubes or tunnels. Three of these are for vehicular, pedestrian, and street-car traffic, leaving the surface at 2nd and Webster streets, running parallel to the estuary until they are far down enough to permit of a subaqueous crossing, then crossing the estuary and rising in a straight line to a point in Alameda between Webster street and the Southern Pacific railway, about 2000 ft. south of the Webster street bridge. This scheme will provide for a 22-ft. clear roadway in the centre tube. In each of the side tubes provision is made for one-way street-car traffic and for two 5-ft. sidewalks. Railway traffic is to be served by a double-tube tunnel with a single track in each tube leaving the surface in Oakland at the same point as the other tubes, paralleling the estuary in a westerly direction and crossing on an extension of Jefferson street. This gives the best practicable alignment for the Southern Pacific suburban service between Alameda mole and Oakland. The estimated cost of this plan is $10,000,000. It might be noted that this estimate was prepared in 1913 when the price of steel was considerably lower than it is at present.

Plan B is based on the use of the street-car tunnels by the railway traffic, leaving only three tubes to be constructed. This would require a readjustment of the Southern Pacific tracks in Alameda, and would involve some interruption to traffic on account of the varying speeds of the Southern Pacific trains and the street-cars. The estimated cost is $6,800,000.

Plan C calls for a single-tube highway tunnel for vehicular and pedestrian traffic, and would be only a partial solution of the problem. Its estimated cost is $3,400,000. The increased price of steel would make the cost of construction considerably greater at the present time under any of these plans.

It should be noted that the report does not recommend a subway at all. On account of the nature of the original instructions it was impossible for the report to consider in detail any other remedy for the present conditions at the estuary. The report does state that a much less expensive method would be the construction of a heavier bridge of the bascule type. There are several types of bascule bridges which do not require a mid-channel pier, which give ample width of opening and which are so designed that they can be opened or shut much more certainly and rapidly than a swing bridge.

Besides the great cost, the main objections to the subway are its length and crooked alignment at the Oakland end. This is necessitated by the depth to which the subway must be carried. The Federal Government requires a depth in the channel of not less than 40 ft. below low water. The internal diameter of the tube recommended is 26 ft. 6 in. and its thickness 2 ft. The grade recommended is 4½% which, if a straight tunnel were adopted, would bring the portal to 4th street and the end of the open cut to 7th street. This would necessitate closing 5th and 6th streets and would also cause considerable loss of time to traffic originating closer to the channel. The curved alignment at the Oakland end is therefore necessary.

No exhaustive study of the bascule-bridge plan has been made, but the Scherzer company of Chicago has prepared tentative plans for a single bascule bridge to take the place of the Webster Street and Harrison Street bridges. It would accommodate two tracks for street-cars, two tracks for railway trains, a 35-ft. roadway for vehicles, and two 8-ft. sidewalks. The estimated cost is $753,000 exclusive of land. The bridge would have a clearance of 25 ft. above high water. The roadway of the bridge would be about 30 ft. above the general street elevation in that part of the city, so that the approach would be comparatively short. The clear opening would be 200 feet.

A traffic census taken in February 1912 showed that the bridges were opened 103 times during the busiest nine hours of each day for one week for a total length of time of 562 minutes or 5½ minutes each. On account of the greater clearance under the proposed bascule bridge it is estimated that 75% of the vessels which now require the opening of the bridges could pass under the proposed bridge without interruption to traffic. The length of the interruptions would also be considerably reduced.

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Engineers' Note Book

CHART FOR COMPUTING EXCAVATIONS

The accompanying chart, which is taken from the *Excavating Engineer*, will be found useful in computing the approximate volume of excavations with vertical sides, and can also be adapted to computations for sloping sides. The lines on the chart show the method of computing the volume of an ex-

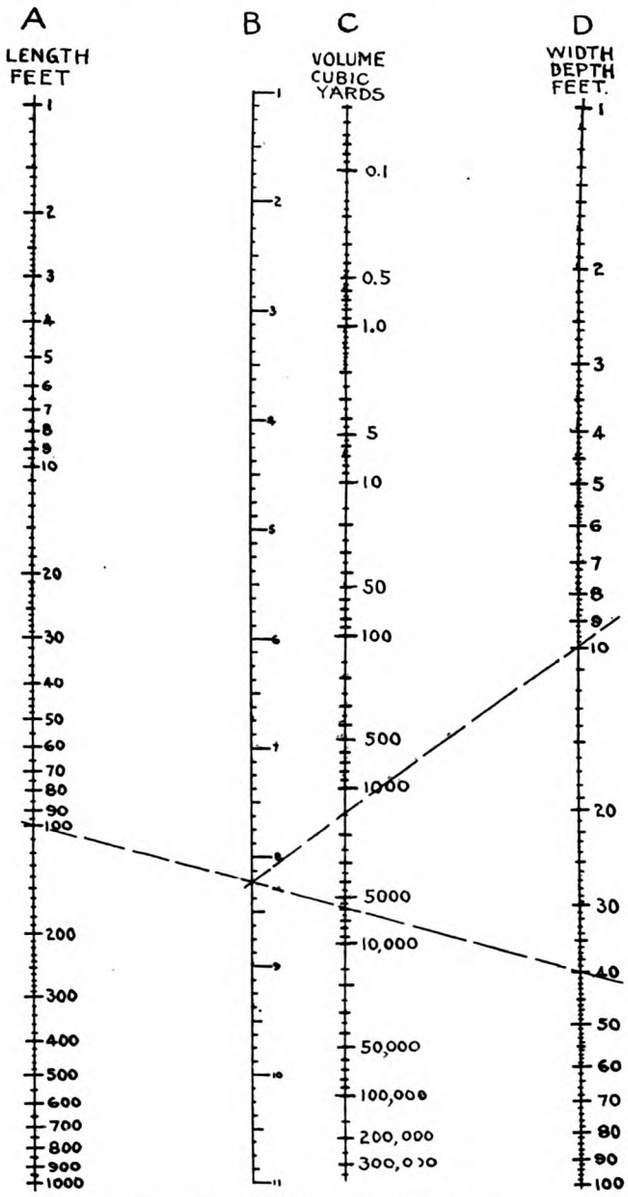


CHART FOR COMPUTING EXCAVATIONS.

cavation 10 ft. deep by 40 ft. wide by 100 ft. long. Draw line from point 100 in column *A* to point 40 in column *D* and mark the intersection with column *B*. From this point draw line to point 10 on column *D*. At the intersection with column *C* read 1500 cu. yd., the volume of the excavation.

Where two dimensions are alike, the work is still simpler. If the excavation is 40 by 40 by 100 ft., it is only necessary to draw the line from 100 on column *A* to 40 on column *D* and read the quantity, 6000 cu. yd., directly from column *C*.

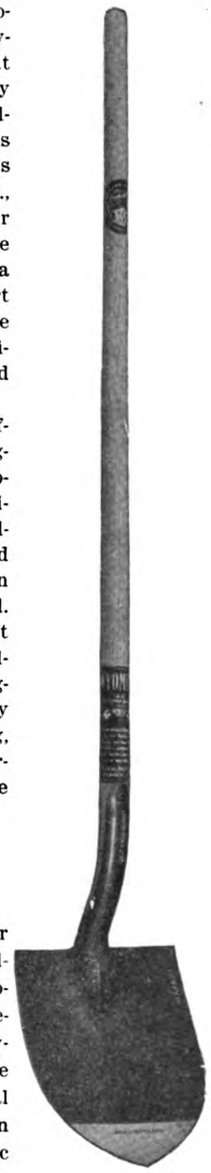
For a cut 100 ft. long, 40 ft. wide at the bottom, 60 ft. at the top, and 10 ft. deep, proceed as for a cut with vertical sides 50 ft. wide.

Industrial Progress

IMPROVEMENTS IN SHOVELING

Contractors who handle their grading work on an efficiency basis have given considerable thought to shoveling. At first this would seem too paltry an operation to be systematized, as, indeed, it has appeared to many. But Frederick W. Taylor, conducting experiments at the plant of the Bethlehem Steel Co., was actually able to produce a tangible saving in shoveling costs of $36,417.69 in one year. This was effected by giving the men shovels that would hold a load of exactly 21 lb., different types of shovels being used for materials of different weights, since the 21-lb. load shovel was found to handle a maximum yardage with minimum effort for the shoveler. Such shovels have since come into wide use in mines, their efficiency having been established beyond question.

A still later development has been effected through making the shovel's digging-edge of chrome-nickel steel which, obviously, lengthens the life to an appreciable extent and also does away with bending the edge through contact with hard material. The steel wears down to a thin edge without being otherwise affected. Such a shovel is illustrated herewith. It holds a 21-lb. load, its edge is of nickel-steel, and it is known as the 'Wyoming-Mayari Red-edge Shovel,' manufactured by the Wyoming Shovel Works, Wyoming, Pennsylvania. For the Pacific Coast, Harron, Rickard & McCone, San Francisco, are the selling agents.



THE WYOMING SHOVEL.

CUTTING EDGE OF SHOVEL.

AN IMPROVED OIL-ENGINE

In a 44-page publication the Bessemer Gas Engine Co. of Grove City, Pennsylvania, describes the manufacture and operation of its well-known engines in detail. The company is constructing a heavy-duty type of hot-bulb or semi-Diesel engine which merits consideration. Its general design (two-cycle principle) has much in common with that of the modern automatic steam-engine. The reciprocating parts are fully enclosed and run in an oil-bath. The connecting-rod thrust is borne by a cross-head fitted with adjustable bronze shoes. The design of the crank-shaft bearings is novel, combining, as it does, the virtues of the four-part box with the simplicity and the rigidity of the two-piece bearing-shell. The connecting rod is of the marine type, fitted with babbitt-lined bronze shell in the crank-pin end and a solid bush at the cross-head pin.

The scavenging air does not pass through the crank-case, but is compressed in the crank-end of the cylinder instead, the latter being isolated from the crank-case by a stuffing-box, fitted with bronze-metallic packing. The inlet-valve which admits the scavenging air to the crank-end of the cylinder is of the Corliss type and double-ported. It is silent in op-

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eration and efficient, the pressure-drop through the valve-ports being less than one-half pound.

The fuel-pump is operated by an eccentric carried by a shaft-governor of the inertia type.

Water feed to the combustion-chamber is handled by a small pump also under governor control. This pump is mounted in the fuel-pump housing and driven from the fuel-pump cross-head to a short reversing lever.

The governor itself is of rather peculiar design, having been devised to meet the conditions imposed upon it by this particular class of service.

The engine will operate satisfactorily on a broad range of fuels without change of adjustment. This range includes the oils put on the market recently by many of the larger refineries and known as Diesel engine fuel-oils.

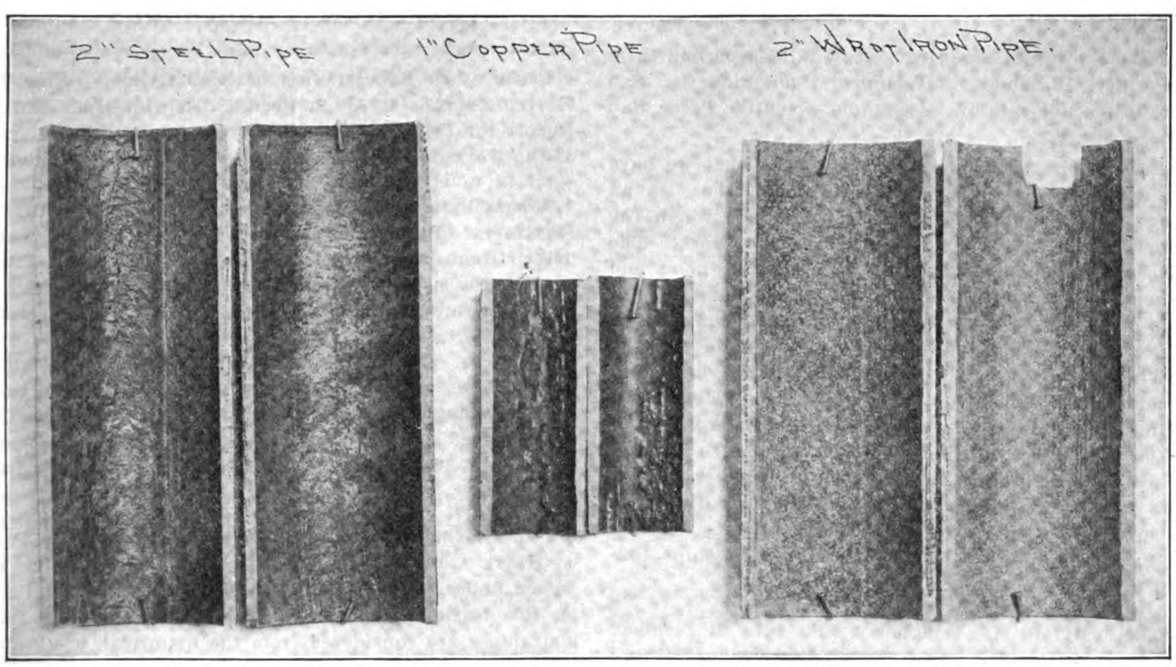
This design is conspicuous for its ruggedness and weight. Bearing dimensions are unusually large and hardened, and ground-work is used throughout on all small steel wearing-parts, opposed to phospher-bronze bushings, which are renewable.

PREVENTION OF CORROSION IN PIPE

In a 15-page illustrated pamphlet, the reprint of a paper presented by F. N. Speller of Pittsburg at the annual meeting of the American Society of Heating and Ventilating Engineers, is a great deal of interesting matter on the important subject of pipe corrosion.

Casual observation will show marked differences in the degree of corrosion of pipe in service. For instance, hot-water heating-systems and sprinkler-systems show practically no deterioration in service after 25 years, while low-pressure steam returns sometimes give trouble after 15 years' service or less. Galvanized pipe in hot-water supply-systems, where the water is heated under pressure, lasts from about 5 years upward, depending on the temperature and quality of the water and volume of flow. The last-named condition is so severe on iron and steel pipe that many are compelled to use brass pipe, at a cost approximately 10 times that of galvanized pipe. These few instances are the extremes, but are surely suggestive when it is considered that in pipe carrying ordinary water under some conditions there is no apparent deterioration in a generation; whereas in other cases, the same grade of pipe is seriously damaged in a few years. Some years ago, when steel pipe was comparatively unknown and not fully developed, it was natural to question this material; but comparisons of the modern wrought iron and steel pipe in the same lines in service have shown beyond any question that where corrosion is found, one material suffers on the average as much as the other.

Water alone is not responsible for corrosion, but rather something brought in with the water. All water supplies carry more or less foreign matter in solution. The purest natural supplies are generally saturated with oxygen and carbonic acid, which cause such water to be very corrosive, particularly when heated. Iron is soluble to a certain extent in water. The phenomenon of solution of iron is an electro-chemical reaction, which is the initial cause of corrosion, hastened by carbonic acid and mineral salts dissolved. Oxygen is also necessary for a continuance of corrosion. The elimination of dissolved oxygen is one remedy to reduce 'pitting' of pipe. An alternative method is to 'satisfy' or fix the free oxygen, using clean iron turnings, or preferably sheet iron, through which the water can flow. The accompanying electrotype shows some 2-in. wrought iron and steel pipe (galvanized) after 13 years use in an 'open' heating system, while the small pipe is of copper, used under the same conditions in a 'closed' heating system for 6 months. The corrosion of low-pressure steam lines depends principally on the amount of oxygen that finds access to the system.



CORROSION IN VARIOUS TYPES OF PIPE. (Photo from National Tube Co.)

Summarizing very approximately, Mr. Speller considers that in the influence of various factors on corrosion, it appears from the experience gained so far that developments in the metallurgy and manufacture of steel pipe promise to add 50 or perhaps 100% to the life of pipe compared with the service obtained under like conditions 10 or 12 years ago. However, it appears well within the bounds of possibility to predict that de-aeration of the water, through the use of plants designed with this end in view, should at moderate expense increase the life of some piping systems four or five times.

Bulletin No. 26 of the National Tube Co. consists of 47 pages describing in an informing manner the autogenous welding of 'National' pipe. As oxy-acetylene gas is used so much for welding and cutting now-a-days, every engineer should secure a copy of this useful publication.

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Book Reviews

PROCEEDINGS OF THE PAN-AMERICAN ROAD CONGRESS. P. 416. Executive Committee Pan-American Road Congress, 150 Nassau street, New York. Price, $2.

The papers and discussions presented at the Pan-American Road Congress in Oakland last September, are now available in book form. The papers deal with almost every phase of highway construction. While little that is new was brought out, the student of highway problems will probably find the complete report of interest.

PROCEEDINGS OF THE SECOND NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING. P. 320. Ill., index. The National Conference on Concrete Road Building, 111 West Washington street, Chicago. Price, $1.

As most of our readers are aware, the Conference on Concrete Road Building last winter was an important gathering. A well-arranged volume containing the proceedings of the Conference is now available to the public. There are several addresses on highway topics, but most of the book is devoted to reports of 17 committees regarding branches of concrete-highway construction, together with the discussions of these reports. A set of standard specifications is also included. The book will be invaluable to those who are interested in highway construction.

THE DIESEL ENGINE IN PRACTICE. By J. E. Megson and H. S. Jones. P. 136. Ill., index. Technical Publishing Co., San Francisco, 1916. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.

This is the second book on the Diesel engine that we have reviewed during recent months, and although there is an interesting lot of information included, it is not worth the price, other things being equal, with the other work. The subject is brought home to California engineers by notes and photographs (not very clear) of two makes of Diesels at the Exposition last year, and mention of the ship *Siam*, which called here. The first chapter gives a brief history of the engine. This is followed by operation of the two and four-cycle machine, with efficiencies, heat balance, etc. Experience with earlier installations is of interest. As fuel-oil is the source of power in the Diesel, a chapter is devoted to it. The effect of altitude is next discussed, as such engines do not develop as much power as at sea-level. Practical directions cover the operation and care of the Diesel, and its life and reliability. The commercial situation and use in ships concludes the work.

HYDRAULICS. By R. L. Daugherty. P. 264. Ill., index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.50.

The author states in his preface that this volume has been prepared for students who are required to cover a wide field in hydraulics in a limited amount of time, by which he probably means technical students of other branches than civil engineering. Civil engineering students and practising civil engineers will probably prefer to make use of some of the other text-books on the subject, but students as well as many engineers in other lines will probably find the present volume of value, although the limited space necessitates a somewhat hasty treatment of certain parts of the subject. An unusual feature of the book is the development of the laws governing the flow of water from Bernouilli's theorem, instead of starting from $V^2 = 2gh$ and proceeding to the many cases where it is not equal. While this is probably the most logical way of approaching the subject, it is doubtful whether it is the clearest to the average student. After a general introduction, the theory of hydrostatic pressure is developed and its application to the design of dams shown. The flow of water is then considered, first in general, then through pipes and in open channels. Impulse wheels and reaction turbines together with complete power-plants are then discussed. The last chapter is devoted to the centrifugal pump. The book is well illustrated. Many of the photographs are of structures in the Pacific Coast States.

HYDRAULIC TABLES. By Joseph H. Harper. P. 192. Ill. D. Van Nostrand Co., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.

This book is designed to lighten the labors of the user of hydraulic formulae. The main body of the tables is divided into four parts, for flow in pipes, by D'Arcy's and by Kutter's formula, flow in open rectangular channels by Kutter's formula, flow in open trapezoidal channels by Bazin's and by Kutter's formula, and flow in egg-shaped conduits by Kutter's formula. The latter table is divided into three parts, for flow when running one-third full, two-thirds full, and full. All the tables are computed for several different conditions of roughness. Besides these tables there are others with considerable miscellaneous data, and also a discussion of the various formulae. An appendix contains a number of charts showing by means of curves, the different results obtained by the use of the different formulae.

New Publications

PROGRESS IN RECLAMATION OF ARID LANDS IN THE WESTERN UNITED STATES. By J. B. Beadle. Reprint from Smithsonian Report for 1915. P. 22. Ill. Gives a non-technical summary of the work of the U. S. Reclamation Service to date.

A NEW PENETRATION NEEDLE FOR USE IN TESTING BITUMINOUS MATERIALS. By Charles S. Reeve and Fred P. Pritchard. Reprint from Journal of Agricultural Research. P. 12. Ill. The needles used at present in making these tests give widely-varying results, so a new standard needle is suggested.

TESTS OF THREE LARGE-SIZED REINFORCED CONCRETE SLABS UNDER CONCENTRATED LOADING. By A. T. Goldbeck and E. B. Smith. Reprint from Journal of Agricultural Research, Department of Agriculture. P. 32. Ill. The slabs in question were 16 by 32 ft. with effective thicknesses ranging from 6 to 10½ inches.

THE HISTORY AND ECONOMICS OF GUARANTEES OF PAVEMENT ON STATE AND MUNICIPAL HIGHWAYS. By George C. Warren. Issued under the auspices of the Council of National Advisors of the National Highway Association. P. 27. Pavement guarantees are considered from the historical, legal, and practical standpoints. The general trend of the argument is that such guarantees are inadvisable.

BETTER INDUSTRIAL LIGHTING. The National Electric Light Association, New York. P. 16. Ill. This bulletin discusses the increased production and safety and the decreased amount of poor work resulting from good lighting. The actual gain during the first year in many cases has been several times the cost of installation of the improved lighting system. Suggestions are given regarding proper methods of lighting.

PROCEEDINGS OF THE ELEVENTH ANNUAL MEETING OF THE MID-WEST CEMENT USERS' ASSOCIATION. Omaha, Neb. P. 101. Ill. One of the most active of the smaller cement associations is the Mid-West Cement Users Association. The proceedings of its recent convention have just been published. Much interesting information is given regarding the use of concrete in the construction of farm-buildings, roads, sewer pipe, etc., although much of the data given is naturally of a somewhat local application.

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Engineering Societies

IDAHO SOCIETY OF ENGINEERS. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Edward Woodbury, secretary, 255 East 3rd street.

OREGON SOCIETY OF ENGINEERS. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Section, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Paul Lebenbaum, secretary, 45 Union Depot.

Portland Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. Charles McGonigle, president, care Western Sheet Metal Works.

San Francisco Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. E. T. Thurston, Jr., secretary, Mechanics Institute building.

San Francisco Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Carl F. Braun, secretary, Hooker & Lent building.

San Francisco Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. A. G. Jones, secretary, 811 Rialto building.

Southern California Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. W. K. Barnard, secretary, 701 Central building, Los Angeles.

The regular meeting of the San Francisco Association of Members of the American Society of Civil Engineers was held June 20. A progress report was read from the committee on military preparedness recommending among other things that the organization of civilian engineers in volunteer military bodies be left to the national societies rather than to local organizations and that a committee should be appointed to take up the matter with the Board of Direction of the American Society of Civil Engineers. This recommendation was approved by the members of the Association present. A resolution was adopted indorsing the proposed preparedness parade in San Francisco on July 22 and pledging the association to make up its share of whatever small deficit there may be in connection with the engineers' division of the parade. The paper of the evening on 'The Organization of a Municipal Water Department,' was read by H. A. Whitney.

The members of the American Society of Civil Engineers inspected the work on the Twin Peaks Tunnel and the Ocean Beach Esplanade on June 22, as the guests of city engineer M. M. O'Shaughnessy.

Coming Conventions

AMERICAN ELECTRIC RAILWAY ASSOCIATION. Annual convention, Atlantic City, New Jersey, October 9-13. E. B. Burritt, secretary, 8 West 40th street, New York.

AMERICAN GAS INSTITUTE. Annual meeting, Chicago, October 17-20. G. G. Ramsdell, secretary, 29 West 39th street, New York.

AMERICAN INSTITUTE OF METALS. Annual meeting, Cleveland, Ohio. Week of September 11. W. M. Corse, secretary, 106 Morris avenue, Buffalo, New York.

AMERICAN PEAT SOCIETY. Annual meeting, Washington, D. C., September 21-23. Julius Bordello, secretary, Kingsbridge, New York.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS. Annual convention, Newark, New Jersey, October 9-13. Charles C. Brown, secretary, Indianapolis, Indiana.

ILLUMINATING ENGINEERING SOCIETY. Annual convention, Philadelphia, September 18-20. C. D. Fawcett, assistant secretary, 29 West 39th street, New York.

Personal

O. A. GIERLICH has been appointed city engineer of El Monte, California.

LEE A. GRANGER has been appointed deputy city engineer of Fresno, California.

GEORGE BOWEN has been appointed head of the water department of Aberdeen, Washington.

W. B. ELLIOTT has been re-appointed engineer for the Water Users' Association of Phoenix, Arizona.

JEROME NEWMAN, chief engineer for the California State Harbor Commission at San Francisco, has resigned.

SAMUEL HILL, of Maryhill, Washington, has gone to Vladivostok to take charge of the traffic department of the Trans-Siberian railroad.

E. E. CALVIN, formerly vice-president and general manager of the Oregon Short Line has been elected president of the Union Pacific railroad.

C. P. BOWIE, formerly engineer for the Associated Pipe Line Co. and recently appointed petroleum engineer for the U. S. Bureau of Mines, is in San Francisco.

W. E. TRETHEWAY, president and general manager of the Stockton Iron Works, and designer of much excavating and dredging machinery, has retired from active business.

E. T. LEDNUM has left Chicago and has gone to Joplin, Missouri, where he will be manager of a new office recently opened at that place by E. I. Du Pont de Nemours & Company.

L. C. HILL, consulting engineer for the U. S. Reclamation Service is at Fresno, California, investigating the project for a reservoir at Pine Flat for storing the waters of Kings river.

R. V. ORBISON, city engineer of Pasadena, California, has been in Salt Lake City, conferring with members of the Utah State Board of Health with regard to sewer systems in Utah.

The firm of DAY & PHELAN, civil and landscape engineers, of Santa Barbara, California, has been dissolved, and the business of the firm will hereafter be conducted by S. H. PHELAN.

J. R. WEST, chief engineer for the port of Seattle since January 1914, has resigned and will go to China to take the chair of railroad engineering at the University of Pei Yang, Tientsin.

JOHN S. EASTWOOD, consulting hydraulic engineer, has been at Salt Lake City, inspecting the construction of the new multiple-arch dam that is being constructed for the city in Parley's canyon.

JOHN B. YEON, roadmaster of Multnomah county, Oregon, has been presented with a silver plaque in honor of his services in connection with the construction of the Columbia River highway.

E. B. RHINE, formerly engineer for the California State Highway Commission, has been appointed junior civil engineer for the Interstate Commerce Commission, with headquarters at San Francisco.

T. W. ALLEN, highway engineer for the U. S. Department of Agriculture is making a study of highway conditions in Santa Cruz county, California, with a view to the planning of a county highway system.

Commercial Paragraphs

The WATERLOO CEMENT MACHINERY CO. has recently issued a 24-page booklet describing the 'Wonder Mixers' manufactured by the company.

The KINNEY MANUFACTURING CO. has sold two 15-in., twelve 8-in., and four 5-in. rotating-plunger pumps to the Texas Co. for use at its refineries at Port Arthur and Port Neches, Texas.

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Western Engineering

WEEKLY NEWS BULLETIN

WESTERN ENGINEERING *with* WEEKLY NEWS BULLETIN $4.50 per Year

SAN FRANCISCO, JULY 3, 1916

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CONTRACTS PENDING

Bids will be Received		See Issue of News Bulletin
July 3.	Dayton, Wash., Road Work	July 3
July 3.	Everett, Wash., Road Work	July 3
July 3.	Huntington Beach, Cal., Light and Heat	July 3
July 3.	Los Angeles, Cal., Road Work	June 26
July 3.	Los Angeles, Cal., Street Work	July 3
July 3.	Quincy, Cal., Bridge	May 29
July 3.	Redding, Cal., Bridge	May 29
July 3.	San Bernardino, Cal., Sewer	June 26
July 3.	San Jose, Cal., Bridge	June 12
July 3.	San Jose, Cal., Road Work	June 12
July 3.	San Rafael, Cal., Road Work	June 12
July 3.	Santa Barbara, Cal., Bridges	July 3
July 3.	Santa Barbara, Cal., Road Work	July 3
July 3.	Vancouver, Wash., Street Work	June 19
July 3.	Yreka, Cal., Bridge	June 19
July 5.	Eureka, Cal., Supplies	July 3
July 5.	Fullerton, Cal., Machinery	June 26
July 5.	Roseburg, Ore., Road Work	June 26
July 5.	Salem, Ore., Miscellaneous	July 3
July 5.	Salinas, Cal., Road Work	June 12
July 5.	Salt Lake City, Utah, Street Work	June 19
July 5.	San Francisco, Cal., River Work	June 26
July 5.	San Rafael, Cal., Street Work	June 19
July 5.	Ukiah, Cal., Bridge	June 19
July 5.	Ukiah, Cal., Road Work	June 19
July 5.	Visalia, Cal., Bridges	June 19
July 5.	Washington, D. C., Supplies	June 26
July 6.	Bakersfield, Cal., Bridge	June 26
July 6.	Ephrata, Wash., Road Work	June 19
July 6.	Merced, Cal., Light	June 26
July 6.	Oakland, Cal., Sewer	June 26
July 6.	Oakland, Cal., Street Work	June 26
July 6.	Orange, Cal., Machinery	June 26
July 6.	Oroville, Cal., Heat	June 26
July 6.	Port Orchard, Wash., Road Work	July 3
July 6.	Sacramento, Cal., Sewers	July 3
July 6.	Santa Barbara, Cal., Sewer	July 3
July 6.	Santa Barbara, Cal., Street Work	July 3
July 6.	Spokane, Wash., Bridges	June 19
July 7.	Lindsay, Cal., Irrigation	June 26
July 7.	Nordhoff, Cal., Buildings	July 3
July 7.	Pullman, Wash., Building	June 12
July 7.	Ventura, Cal., Bridge	June 19
July 8.	Red Bluff, Cal., Bridge	July 3
July 8.	Ventura, Cal., Bridges	July 3
July 8.	Washington, D. C., Harbor Work	July 3
July 10.	Bakersfield, Cal., Sewers	July 3
July 10.	Colville, Wash., Road Work	July 3
July 10.	Everett, Wash., Road Work	June 19
July 10.	Lompoc, Cal., Sewer	July 3
July 10.	Los Angeles, Cal., Water Supply	June 26
July 10.	Sacramento, Cal., Road Work	July 3
July 11.	Berkeley, Cal., Building	July 3
July 11.	Berkeley, Cal., Street Work	July 3
July 11.	Concrete, Wash., Street Work	June 26
July 11.	Sacramento, Cal., Street Work	July 3
July 11.	Seattle, Wash., Road Work	June 26
July 11.	Washington, D. C., Machinery	July 3
July 12.	Berkeley, Cal., Building	June 19
July 13.	Anaheim, Cal., Street Work	June 19
July 13.	Martinez, Cal., Building	July 3
July 13.	Oakland, Cal., Street Work	July 3
July 13.	Oroville, Cal., Bridge	June 26
July 13.	Sacramento, Cal., Street Work	July 3
July 14.	San Jose, Cal., Bridge	July 3
July 14.	Seattle, Wash., Water Supply	June 26
July 14.	Washington, D. C., Building	June 12
July 15.	San Jose, Cal., Drainage	July 3
July 17.	Canby, Ore., Water Supply	July 3
July 17.	San Diego, Cal., Bridge	June 26
July 17.	Stockton, Cal., Bridge	July 3
July 18.	Salt Lake City, Utah, Street Work	July 3
July 18.	St. Ignatius, Mont., Irrigation	June 19
July 19.	Portland, Ore., Bridge	July 3
July 24.	Los Angeles, Cal., Building	July 3
July 25.	Napa, Cal., Bridge	June 26
July 25.	Napa, Cal., Road Work	June 26
July 26.	Bakersfield, Cal., Street Work	June 19
Aug. 1.	Bangkok, Siam, Machinery	June 26
Aug. 1.	Billings, Mont., Street Work	July 3
Aug. 7.	Washington, D. C., Building	June 19

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Construction News

STREET AND ROAD WORK

Auburn, Cal.—Bond issue of $25,000 for paving State highway within city limits has been voted.

Bakersfield, Cal.—F. W. Nightbert has been awarded contract for grading and tamping on Beale avenue for $0.017 per sq. ft. and for similar work on C street for $0.015 per square foot.

Bellingham, Wash.—Contract for construction of 4½ miles of one-course pavement between Marietta and Nooksack river has been awarded to T. Ryan & Co. for $54,994.

Berkeley, Cal.—Contract for improvement of Walnut street has been awarded to Hutchinson Co., 13th and Franklin streets, Oakland, at the following unit prices: excavation, $0.30 per cu. yd.; oil macadam pavement, $0.085 per sq. ft.; concrete gutters, $0.13 per sq. ft.; concrete curbs, $0.40 per ft.; 7 by 30-in. corrugated iron culvert, $2.60 per ft.; 6 by 24-in. culvert, $2.30 per ft.; concrete wall, $10 per cu. yd.; pipe rail, $0.25 per foot.

Contract for improvement of Tamalpais street has been awarded to Western Construction Co. at the following unit prices: grading, $0.0125 per sq. ft.; concrete pavement, $0.135 per sq. ft.; concrete curbs, $0.40 per ft.; curb inlets, $25.25 each.

Bids will be received until July 11 by A. G. Briggs, city clerk, for grading and construction of asphaltic concrete pavement on concrete base, concrete curbs and gutters, and corrugated iron culverts on Grove street.

Contract for improvement of Dwight way has been awarded to Oakland Paving Co., 5000 Broadway, at the following unit prices: excavation, $0.012 per sq. ft.; asphaltic pavement, $0.118 per sq. ft.; concrete curb and gutter, $0.50 per ft.; concrete curbs, $0.45 per ft.; 7 by 30-in. cast-iron culverts, $1.95 per ft.; 6 by 24-in. culverts, $2 per ft.; 5 by 18-in. culverts, $2 per foot.

Billings, Mont.—Bids will be received about August 1 by city clerk for construction of 25,000 sq. yd. of pavement. Alternate bids will be received on gravel, bitulithic, bituminous concrete, concrete, and asphaltic macadam. E. M. Sneckenberg is city engineer.

Camas, Wash.—Plans are being prepared for construction of concrete pavement, curbs, and sidewalks on several streets. C. E. Farr is town clerk.

Colville, Wash.—Bids will be received until July 10 by County Commissioners for construction of three miles of gravel road on permanent highway No. 2. Plans from county engineer upon deposit of $5.

Bids will also be received until the same time for construction of 3.5 miles of crushed-rock surface on permanent highway No. 2-A. Plans from county engineer upon deposit of $3.

Dayton, Wash.—County Commissioners will receive bids until July 3 for surfacing 17 miles of permanent highway No. 1-A with crushed rock.

Everett, Wash.—County Commissioners will receive bids until July 3 for construction of highway near Stanwood, including 5800 cu. yd. excavation and 15,000 sq. yd. concrete pavement.

Contract for construction of one mile of Stanwood highway has been awarded to Cascade Construction Co., Seattle, for $9954.55.

Contract for grading Arlington-Silvana highway has been awarded to Reinseth Bros. for $13,940.94.

Exeter, Cal.—Plans are being prepared for construction of 300,000 sq. ft. of asphaltic concrete pavement on concrete base. H. D. Watts is city engineer.

Lindsay, Cal.—Proceedings have been commenced for construction of 90,000 sq. ft. of asphaltic concrete pavement on concrete base. H. D. Watts is city engineer.

Los Angeles, Cal.—Bids will be received until July 3 by Board of Public Works for the following street work: asphalt pavement, curbs, sidewalks, granite-block gutter, and sanitary-sewer connections on Alexandria avenue, asphalt pavement and granite-block gutter on Ceres avenue.

Contract for improving alley west of Berendo street has been awarded to William Liddington, 420 East 60th street, for $1051.65.

Contract for improving 74th street has been awarded to Coast Construction Co., 1419 East 29th street, for $1145.79.

Contract for highway construction in road district No. 78 has been awarded to E. A. Baker, 407 H. W. Hellman Bdg., for $10,855.

Contract for improving Hillside drive has been awarded to Calvin McCray, 5263 Aldama street, for $1695.34.

Merced, Cal.—Plans for improvement of several streets have been postponed until next year.

Myrtle Point, Ore.—Contract for paving several streets has been awarded to Longston Construction Co., Coquille, for $22,942.

Oakland, Cal.—Bids will be received until July 13 by L. W. Cummings, city clerk, for the following street work: grading and construction of redwood curbs, concrete gutters, and oil macadam pavement on 89th avenue; grading and construction of redwood curbs, concrete gutters, and oil macadam pavement on East 17th street.

Contract for improvement of 45th avenue has been awarded to Hutchinson Co., 13th and Franklin streets, at the following unit prices: excavation, $0.15 per cu. yd.; redwood curbs, $0.095 per ft.; concrete gutters, $0.13 per sq. ft.; oil macadam pavement, $0.075 per sq. ft.; cement sidewalks, $0.09 per sq. ft.; 8 by 24-in. corrugated iron and concrete culvert, $1.90 per ft.; 12-in. conduit, $0.75 per ft.; manholes, $35 each.

Contract for improvement of East 14th street has been awarded to Ransome-Crummey Co., First Savings Bank Bdg., for $101,000.

Port Orchard, Wash.—Bids will be received until July 6 by R. E. Gordon, county auditor, for construction of one mile of permanent highway No. 1-B.

Pullman, Wash.—Contract for paving several streets has been awarded to Washington Paving Co., Seattle for $10,000.

Raymond, Wash.—Contract for construction of Smith Creek highway has been awarded to Hasting, Wagner & Meyer for $3089.

Contract for construction of highway to South Bend has been awarded to T. H. Cochran & Sons, St. Johns, Ore., for $20,900.

Richmond, Cal.—Paul Schnerr, Berkeley, was low bidder at $33,187.17 for paving one mile of State highway through city. Other bidders were: S. C. Rodgers, $35,599.59; Municipal Improvement Co., $35,810.30; F. R. Ritchie, $36,320.89; Ransome-Crummey Co., $37,960.37; Johnson-Shea Co., $38,798.37.

Riverside, Cal.—Contract for improvement of Fairmount boulevard has been awarded to Johnson-Shea Co., 5th and Market streets, at the following unit prices: macadam pavement, $0.0625; sidewalks, $0.12 per sq. ft.; combination curb and gutter, $0.60 per ft.; catch-basins, $10 each; a total of $15,388.79. Other bidders were: S. C. Contracting Co., $16,274.13 and Heinauer & Koyle, $19,772.85.

Sacramento, Cal.—State Highway Commission will receive bids until July 10 for the following highway work:

In Marin county from Larkspur to Sausalito, 5.1 miles, to be paved with concrete. Work includes 8100 cu. yd. excavation, 4000 cu. yd. class A concrete in pavement, and 3200 cu. yd. class B concrete in paveemnt. State will furnish cement, sand, and coarse aggregate. Plans from Commission upon payment of $1.89. Checks should be made payable to Forrest Blue Print Company.

In Glenn county, at Walker creek, one mile, to be paved with concrete and including 100-ft. reinforced concrete bridge over Walker creek. Work includes 3300 cu. yd. excavation for highway, 600 cu. yd. excavation for bridge, 60 ft. of 18 and 24-in. corrugated metal pipe, 120 cu. yd. concrete in bridge, 100 cu. yd. concrete in culverts, monuments, and abutments, 198 ft. pipe rail, and 448 ft. guard rail. State will furnish pipe rail, reinforcing steel, corrugated pipe, cement, sand, and coarse aggregate. Plans, $0.68, cross-sections, $0.95.

In Ventura county, one 36-ft. span reinforced concrete bridge, one mile east of Camarillo. Work includes necessary excavation and backfill, 100 cu. yd. old abutments to be broken and placed as riprap, 170 cu. yd. concrete, 17,800 lb. reinforcing steel, and 127 ft. pipe rail. State will furnish pipe rail, steel, and cement. Plans, $0.27.

Contract for improvement of Channing way has been awarded to Clark & Henery Construction Company.

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Contract for improvement of alley between P and Q streets has been awarded to McGillivray Construction Company.

Contract for improvement of Sylvan way has been awarded to Clark & Henery Construction Company.

Contract for improvement of alley between K and L streets has been awarded to McGillivray Construction Company.

Contract for improvement of Bonita avenue has been awarded to A. Teichert & Son.

Contract for improvement of 16th street has been awarded to McGillivray Construction Company.

Contract for construction of State highway in Humboldt county between Loleta and Beatrice, 4.3 miles, has been awarded to Elsemere & Jacobs, Eureka, at $0.48 per cu. yd. for excavation and $4.50 per cu. yd. for concrete in pavement, a total of $23,080. Other bidders were: A. J. and J. L. Fairbanks, $27,287.50; Manuel Jacinto, $31,225; W. A. Newsom, $34,230; Mercer-Fraser Co., $34,825; G. W. Connors, $43,125. Engineers' estimate was $30,446.25. State will furnish cement, value $12,360.

Contract for construction of 2.5 miles of State highway on San Pablo avenue from Alameda county line to Richmond has been awarded to Blanchard-Brown Co., 660 Market street, San Francisco, at the following unit prices: excavation, $0.49 per cu. yd.; 12-in. corrugated pipe, $0.49 per ft.; 15-in. pipe, $0.62; 18-in. pipe, $0.75; 24-in. pipe, $1; concrete in culverts and monuments, $7.55 per cu. yd.; concrete in pavement, $2.83 per cu. yd.; bituminous surface, $0.334 per sq. yd.; setting monuments, $0.90 each; a total of $32,257. Other bidders were: Clark & Henery Construction Co., $32,609; Johnson-Shea Co., $36,497.50; Bates, Borland & Ayer, $38,360; J. W. McDonald, Jr., $39,948.50; W. A. Newsom, $40,078; Ransome-Crummey Co., $41,126; W. J. Schmidt, $48,158. Engineers' estimate was $46,445.05. State will furnish pipe railing, corrugated pipe, reinforcing steel, cement, sand, and coarse aggregate, value $19,392.28.

Modern Construction Co., Inc., Los Angeles, was low bidder for construction of 5.6 miles of State highway in Ventura county between Springville and Santa Clara river, at the following unit prices: excavation, $0.25 per cu. yd.; 18-in. corrugated pipe, $0.50 per ft.; 24-in. pipe, $1; concrete in culverts and monuments, $10 per cu. yd.; concrete in pavement, $3.90 per cu. yd.; guard rail, $0.40 per ft.; setting monuments, $1 each; a total of $31,948.30. Other bidders were: L. G. Garnsey, $34,-709.60; W. A. Kettlewell & Sons, $35,180; Andrew Holloway, $35,-390.80; White & Gaskill, $36,807.80; Mesmer & Rice, $37,396.20; John D. Marsh, $38,277.38; H. E. Cox, $39,929.10; George S. Benson & Sons, $45,753.20. Engineers' estimate was $43,058.42. State will furnish pipe railing, reinforcing steel, corrugated metal pipe, and cement, value, $20,198.68.

J. A. Marshall, Berkeley, was low bidder for construction of 4.2 miles of State highway from Beresford to Redwood City at the following unit prices: excavation, $0.40 per cu. yd.; 12-in. corrugated pipe, $0.30 per ft.; 15-in. $0.40; 18-in. $0.50; 21-in. $0.60; 24-in. $0.70; 30-in. $0.80; concrete in culverts and monuments, $6 per cu. yd.; concrete in pavement, $2.65 per cu. yd.; moving property fences, $0.05 per ft.; new fences, $0.06 per ft.; guard rail, $0.40 per ft.; setting monuments, $1 each; a total of $37,290.50. Other bidders were: Blanchard-Brown Co., $38,-417.60; C. H. and A. W. Gorrill, $39,165; John D. Marsh, $40,-016.50; W. A. Dontanville, $40,364; Eaton & Smith, $41,928.70; Whitlock & Gorrill, $42,421.50; W. A. Kettlewell & Sons, $44,-224; Bates, Borland & Ayer, $46,695; Clark & Henery Construction Co., $47,580.50; Marin Rock Co., $47,990; L. F. Gerdetz Co., $48,183; Petersen & Grier, $49,223.50; O'Brien Bros., $49,696; W. A. Newsom, $49,907.50; J. W. McDonald, Jr., $50,148.50; Manuel Jacinto, $52,922; Raisch Improvement Co., $56,755.50; P. H. Hoare, $58,125; J. Fitzpatrick, $58,839.50; T. W. McClenahan & Co., $59,286.40. Engineers' estimate was $55,044.75. State will furnish pipe railing for culverts, reinforcing steel, corrugated pipe, lumber, wire, and gates for new fences, cement, sand, and coarse aggregate for concrete, value, $35,531.13.

Bids will be received until 11 a.m., July 11, by M. J. Desmond, city clerk, for construction of eight blocks of 3-in. asphaltic macadam pavement on K street. Also for construction of five blocks of 3-in. asphaltic macadam pavement on 15th street. And until 11 a.m., July 13, for improvement of Bonita avenue.

Contract for improvement of Sacramento avenue has been awarded to Clark & Henery Construction Company.

Contract for improvement of 12th street has been awarded to McGillivray Construction Company.

Contract for improvement of Y street has been awarded to Clark & Henery Construction Company.

State Highway Commission has approved plans for construction of the following units of the State highway: in Mariposa county from Cathay to Agua Fria creek, 7.9 miles; in Sonoma county from Petaluma to Fairville, 5.14 miles; in Santa Clara county from San Tomas Aquino creek to Scotts lane, 0.49 mile. Call for bids for the construction of these units will be issued soon.

Salt Lake City, Utah.—Bids will be received until July 18 by Gordon Snow, city recorder, for construction of sidewalks on several streets. Plans from city engineer S. Q. Cannon upon deposit of $5.

Contract for construction of pavement on several streets has been awarded to Parrott Bros. for $91,712.22.

San Francisco, Cal.—Following street work has been ordered: curbs, sidewalks, and asphalt pavement on Clement street and on Judah street; curbs, sidewalks, sewers, and asphalt pavement on Irving street; curbs, sidewalkss, sewers, and broken rock pavement on Rivera street; asphalt pavement on Arguello boulevard; curbs, sidewalks, sewers, catch-basins, and brick and asphalt pavement on Ellsworth street; grading, concrete walls, sidewalks, curbs, concrete steps, catch-basins, and brick pavement on Fair avenue and part of Lundy's lane.

San Leandro, Cal.—City engineer R. H. Goodwin is preparing plans for paving several streets.

Santa Barbara, Cal.—Board of Supervisors will receive bids until July 3 for fencing land on State highway. Plans from county surveyor upon deposit of $10.

Board of Supervisors will receive bids until July 3 for construction of reinforced concrete cattle-pass on Harris Station-Lompoc highway. Plans from county surveyor upon deposit of $10.

City clerk will receive bids until July 6 for construction of concrete curbs, gutters, and sidewalks, and asphalt pavement on Cacique street.

Santa Cruz, Cal.—T. W. Allen, engineer for U. S. Department of Agriculture, who has been studying county highway problem, has reported in favor of the construction of county highway system comprising 75 miles of concrete roads. Estimated cost is $867,000.

Seattle, Wash.—Contract for construction of Kent-Des Moines highway has been awarded to Charles G. Huber, Central Bdg., for $29,465.

Tacoma, Wash.—Contract for paving 2.12 miles of Pacific highway south of Dupont has been awarded to Independent Asphalt Paving Co. for $34,696.

Vallejo, Cal.—City engineer T. D. Kilkenny is preparing plans for construction of pavement and other street improvements in northeastern part of city.

Following were the unit prices named in the bid of the Worswick Construction Co., which was the lowest bidder for the construction of pavement in northwestern part of the city: excavation, $0.50 per cu. yd.; adobe cut and sand fill under sidewalks, $1 per cu. yd.; concrete curbs, $0.41 per ft.; curb armor, $0.25 per ft.; 4-in. concrete base for pavement, $0.08 per sq. ft.; brick pavement on 2-in. concrete base, $0.25 per sq. ft.; 1-in. asphaltic concrete surface, $0.025 per sq. ft.; reinforced concrete retaining wall, 3 ft. high, $20.50 per cu. yd.; reinforced concrete guard rail, $1 per ft.; concrete sidewalks, $0.105 per sq. ft.; 6 by 16-in. corrugated iron culverts, $1.32 per ft.; 8 by 18-in. culverts, $1.40 per ft.; 8 by 24-in. culverts, $1.50 per ft.; 8-in. circular culverts, $1.50 per ft.; 16 by 16-in. culvert hand-holes, $10.75 each; 18 by 24-in. hand-holes, $18 each; 4 by 8-in. header board, $0.30 per ft.; 4-in. lateral sewers, $1 per foot.

Visalia, Cal.—Board of Supervisors has agreed to open State highway from near Visalia to Kern county line, build all bridges, and do a reasonable amount of grading. The State Highway Commission in its turn agrees to take over and maintain highway when it is completed.

SEWERS AND DRAINAGE

Bakersfield, Cal.—Bids will be received until July 10 by R. G. Ballagh, city clerk, for construction of 6-in. vitrified pipe sewers on several streets.

Lompoc, Cal.—Bids will be received until 7:30 p.m., July 10, by G. W. Meals, city clerk, for construction of sewer system and disposal plant. Plans from city clerk or from Haviland & Tibbetts, Alaska Commercial Bdg., San Francisco, upon payment of $20.

Maricopa, Cal.—L. L. Coleman, city engineer, is preparing plans for septic tank.

Oakland, Cal.—Contract for construction of sewer on D street has been awarded to D. U. Toffelmeier, First National Bank Bdg., San Leandro, at the following unit prices: 8-in. vitrified pipe sewer, $0.80 per ft.; wye-branches, $0.25 each; lampholes, $10 each.

Contract for construction of sewer on Harvey avenue has been awarded to E. H. Sundberg, Oakland Bank of Savings

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Bdg., at the following unit prices: 8-in. vitrified pipe sewer, $0.75 per ft.; wye-branches, $0.45 each; manholes, $45 each; lampholes, $9 each.

The following bids were received for the construction of drainage structures in Beck street from 73rd avenue to Church street, in Church street from Beck street to Foothill boulevard, and in portions of 73rd avenue and Foothill boulevard adjacent, respectively, to Beck street and Church street:

	A	B	C	D	E	F	G	H	I	J
Baker & Martin, 310 Sheldon Bdg., San Francisco	$3.07	$3.51	$4.13	$6.63	$40.50	$2.36	$1.32	$1.27	$27.00	$32.00
Karl Ehrhardt	4.00	4.00	4.20	8.30	55.00	2.75	1.50	1.00	45.00	40.00
M. Murphy	3.50	4.00	4.50	15.00	50.00	2.25	0.20	0.50	42.00	50.00
D. Toffelmeier	3.70	4.00	5.50	5.50	40.00	1.90	1.00	0.80	37.50	10.00
A. Lazzereschi	6.25	6.85	8.18	17.00	125.00	2.50	1.25	1.25	50.00	25.00
Chambers & Heafy	4.75	4.90	4.90	11.00	95.00	2.50	2.00	1.00	60.00	35.00
Bates, Borland & Ayer	3.45	3.86	5.57	11.00	97.00	2.49	0.95	0.60	32.50	25.00
Frank Ostrander	4.50	4.68	4.86	7.00	50.00	2.50	1.00	1.00	40.00	15.00
E. H. Sundberg	3.97	3.75	4.90	8.25	71.00	2.65	0.79	0.25	40.00	25.00
C. H. and A. W. Gorrill	5.40	3.60	5.50	8.50	85.00	2.60	1.00	0.60	40.00	35.00
McCray & Layaz	5.00	4.50	6.00	8.00	50.00	2.00	1.50	1.50	30.00	50.00

(A) price per lineal foot of 3′ by 3′-6″ concrete arch culvert.
(B) price per lineal foot of 2′-6″ by 4′ concrete box culvert.
(C) price per lineal foot of 2′-9″ by 5′ concrete box culvert.
(D) price per lineal foot of 3′-6″ by 6′ concrete box culvert.
(E) price per taper section of concrete culvert, each 10 feet long.
(F) price per lineal foot of 24″ pipe conduit.
(G) price per lineal foot of existing 12″ conduit to be relaid.
(H price per lineal foot of 10″ conduit.
(I) price per manhole.
(J) price per storm-water inlet.

Reedley, Cal.—Contract for construction of improvements to sewer system including sprinkling has been awarded to O. Frederickson, Fresno, for $6428.63.

Richmond, Cal.—Contract for construction of sewers in Richmond Center tract has been awarded to F. R. Ritchie & Co., Chronicle Bdg., San Francisco, for $19,758.65. Other bidders were: Fred Meyer, $21,432.16; L. L. Page, $21,457.94; Staniger & Melloch, $21,929.93; William F. Edwards, $22,772.60; Chambers & Heafy, $25,462.72; Raven Co., $26,135.36.

Sacramento, Cal.—Bids will be received until 11 a.m., July 6, by M. J. Desmond, city clerk, for construction of 6, 8, and 10-in. vitrified pipe sewers in Wright & Kimborough tract No. 27.

Contract for construction of sewers on several streets has been awarded to W. J. Tobin, 735 Filbert street, Oakland.

San Jose, Cal.—Bids will be received until July 15 by directors of Laguna Seca reclamation district, Bank of San Jose Bdg., for construction of drainage system, including about 100,000 cu. yd. excavation. Duryea, Haehl & Gilman, Humboldt Bank Bdg., San Francisco, are engineers.

Santa Barbara, Cal.—City clerk will receive bids until July 6 for construction of 370 ft. of 8-in. vitrified piper sewer on Victoria street.

Tacoma, Wash.—Contract for dredging and diking in Hylebos creek district has been awarded to Tacoma Dredging Co. for $95,274.

BRIDGES AND CULVERTS

Moscow, Ida.—Contract for construction of reinforced concrete bridge over Paradise creek has been awarded to Security Bridge Co., Spokane, Wash., for $3985.

Oroville, Cal.—County surveyor M. C. Polk is preparing plans for 62-ft. concrete bridge across Little Chico creek.

Portland, Ore.—County Commissioners will receive bids until July 19 for construction of concrete arch-bridge and retaining wall on Base Line extension highway.

Red Bluff, Cal.—Bids will be received until July 8 by H. G. Kuhn, county clerk, for construction of wooden bridge over South Dibble creek.

Sacramento, Cal.—Howard S. Williams, Hearst Bdg., San Francisco, has been awarded contract at $18,044 for construction of a 120-ft. reinforced concrete bridge across Salt creek and a 541-ft. reinforced concrete bridge across Sacramento river, both on State highway in Shasta county. Ross Construction Co. bid $25,912. Engineers' estimate was $24,676.38. State will furnish pipe railing, reinforcing steel, steel castings and plates, and cement, value $14,301.55.

Salinas, Cal.—County surveyor H. F. Cozzens has been authorized to proceed with construction of pier for Naciemento bridge by day labor.

San Jose, Cal.—Bids will be received until 11 a.m., July 14, by Board of Supervisors for construction of reinforced concrete bridge on Foothill avenue near Shell place.

Santa Barbara, Cal.—Board of Supervisors will receive bids until July 3 for construction of two reinforced concrete bridges on State highway and one on Harris Station-Lompoc highway. Plans from county surveyor upon deposit of $10 for each set.

Stockton, Cal.—Bids will be received until July 17 by Board of Supervisors for construction of 58-ft. pile-trestle bridge and 2200 cu. yd. of embankment on county highway. F. E. Quail is county surveyor.

Ventura, Cal.—Board of Supervisors will receive bids until July 8 for construction of one 30-ft. wooden bridge, one 39-ft. wooden bridge, and one 105-ft. steel and wooden bridge, all on Matilija highway. Plans from county surveyor upon deposit of $3.

IRRIGATION AND WATER SUPPLY

Berkeley, Cal.—Berkeley Chamber of Commerce is having plans prepared for improvements to system of water-mains for fire-protection in West Berkeley according to suggestions of Board of Fire Underwriters. Estimated cost is $55,000.

Calexico, Cal.—Contract for construction of 1255 ft. of 30-in. concrete pipe and 100 ft. of 16-in. pipe has been awarded to P. L. Hedrick, El Centro, for $2085.

Canby, Ore.—Bids will be received until July 17 by city clerk for construction of water system, including pumping machinery, 75,000-gal. tank, and four miles of distributing mains. Plans from city clerk upon deposit of $6. S. A. Cobb, Oregon City, is engineer.

Hermiston, Ore.—Newport Land & Construction Co. was low bidder for enlargement of feed-canal on Umatilla project, U. S. Reclamation Service, at the following unit prices: common excavation, $0.1575 per cu. yd.; loose rock, $0.40 per cu. yd.; solid rock, $0.95 per cu. yd.; concrete, $9.75 per cu. yd.; a total of $32,254. Other bidders were: George P. Wright, Tacoma, Wash., $38,512; H. D. Willis, Boise, Ida., $42,810.

Sacramento, Cal.—Bond issue of $90,000 for construction of irrigation system in Carmichael district has been voted. Morgan Jones, W. J. Phelps, and A. McDonald are trustees. Plans include pumping plant and ditches.

Washington, D. C.—Contract for furnishing 3950 ft. of 60-in. redwood wood-stave pipe has been awarded to Pacific Tank & Pipe Co., San Francisco, for $21,157.

Yreka, Cal.—City Council is preparing to place meters on a number of services supplied by the municipal water-works.

RIVER AND HARBOR WORK

Washington, D. C.—Bids will be received until July 8 by Bureau of Yards and Docks, Navy Department, for dredging 35,000 cu. yd. of material at California City point, near Tiburon, California.

LIGHT, HEAT, AND POWER

Huntington Beach, Cal.—Board of trustees will receive bids until July 3 for furnishing materials for municipal gas-distributing system, including ¾ and 2-in. pipe and connections.

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RAILROAD WORK

Roseburg, Ore.—City engineer Hicks has completed plans for construction of proposed Roseburg & Eastern railroad, 24 miles long. Call for bids will be issued soon.

Seattle, Wash.—Grant, Smith & Co., Henry Bdg., have been awarded contract for construction of extension of Chicago, Milwaukee & St. Paul railroad to Clallam bay.

Vancouver, Wash.—Construction of railroad to Camas, 14 miles, is proposed. G. W. Ford is interested.

BUILDING CONSTRUCTION

Berkeley, Cal.—Bids will be received until July 11 by N. L. Crowl, secretary board of education, 2133 Allston way, for construction of building at Longfellow school. Plans from secretary upon deposit of $2.

Culver City, Cal.—Contract for construction of grammar school has been awarded to C. W. Kent & Son, Glendale, for $39,378.

Eureka, Cal.—Contract for construction of building at Hoopa Valley Indian school has been awarded to Thomas Engelhart for $12,125.

Los Angeles, Cal.—Board of Supervisors will receive bids until July 24 for construction of five-story reinforced concrete service building at county hospital.

Los Banos, Cal.—Bond issue of $63,000 for construction of school building has been voted.

Martinez, Cal.—Bids will be received until July 13 by J. E. Rodgers, clerk board of education, Byron Brown Bdg., for construction of building for Alhambra Union high school.

Milwaukie, Ore.—Contract for construction of school building has been awarded to E. G. Guddard and Pelton & Lowe for $14,797.

Nordhoff, Cal.—Board of trustees of Nordhoff high school district will receive bids until July 7 for construction of two frame buildings. Estimated cost is $12,000. Marsh & Howard, 214 Broadway, Los Angeles, are architects.

Oroville, Cal.—Contract for construction of Olive Products Co. factory has been awarded to A. Plagge. Company will purchase its own construction materials.

Palo Alto, Cal.—Contract for construction of Christian Science church has been awarded to Graves & Son, Los Angeles, for $20,000. H. H. Gutterson, 278 Post street, San Francisco, is supervising architect.

Placerville, Cal.—Contract for construction of tile building for school has been awarded to N. W. Sexton Co., 625 Market street, San Francisco, for $27,000.

Porterville, Cal.—Contract for construction of building on high school ground has been awarded to James Walthall for $15,500.

Portland, Ore.—Order of Moose will construct reinforced concrete building. Estimated cost is $75,000. Houghtaling & Dougan, Henry Bdg., are architects.

San Francisco, Cal.—Plans are being prepared and call for bids will soon be issued for construction of emergency hospital at Polk street and Ivy avenue. Building will be of reinforced concrete. Estimated cost is $100,000.

Stockton, Cal.—Contract for excavation and construction of foundation for Farmers & Merchants Bank building has been awarded to A. Lynch, 185 Stevenson street, San Francisco, for $17,500.

Wenatchee, Wash.—Bird & Hobson, who were awarded contract for construction of post-office, have withdrawn from contract, and it has been awarded to H. F. Allen, Empire Bdg., Seattle, for $81,000, using limestone.

Woodland, Cal.—Bond issue of $200,000 for construction of courthouse has been voted. This amount was voted at an election two months ago, but the election was illegal because of a technicality.

MACHINERY AND SUPPLIES

Eureka, Cal.—Bids will be received until July 5 by J. P. Wunderlich, city clerk, for furnishing 500 ft. of 2½-in. double-jacketed cotton fire-hose with couplings, and 200 ft. of ¾-in. four-ply chemical hose with couplings.

Bids will be received until July 5 by J. P. Wunderlich, city clerk, for furnishing on or before September 1, 7350 ft. of 8-in. wood-stave redwood pipe, machine-banded in factory or on job.

San Bernardino, Cal.—Contract for furnishing fuel oil for schools has been awarded to Colton Oil & Implement Co. at $1.24 per barrel.

Washington, D. C.—Bids will be received until July 11 by Bureau of Supplies and Accounts, Navy Department, for delivery at Mare Island, Cal., of three motor generators.

MISCELLANEOUS

Ray, Ariz.—Contract for construction of bulkhead and concrete retaining-wall for Ray Consolidated Copper Co. has been awarded to Mesmer & Rice, Marsh-Strong Bdg., Los Angeles, for $43,000.

Salem, Ore.—Bids will be received until July 5 by John H. Lewis, State engineer, 303 Capitol Bdg., for quarrying, crushing, and screening approximately 9000 cu. yd. of rock near Siskiyou, Oregon.

San Francisco, Cal.—Bid of Mare Island Navy Yard of $4457.65 for docking and repairing tender 'Madrono' has been accepted. Moore & Scott Iron Works bid $4630.90 and Union Iron Works bid $5174.

Building Permits

JUNE 22

Three Story Frame Flats—Cost $4500. F. H. Dietsche, owner. E Presidio 110 S Bush.

Flat Alterations—Cost $2500. Emily Martin, owner. 1361 California.

JUNE 23

Ice Skating Rink Alterations—Cost $10,000. Pavilion Ice Palace, owner. SE Pierce and Sutter.

Two Story Frame Dwelling—Cost $2922. Johanna Gebhart, owner. W Shotwell 134 S 22nd.

Two Story Frame Flats—Cost $7250. G. B. Schiaffine, owner. S Green 175 E Pierce.

Two Story Concrete Loan Office—Cost $40,000. San Francisco Remedial Loan Association, owners. NW Mint Ave and Mission.

JUNE 24

Three Story Brick Tenements—Cost $20,000. W. G. Gilmour, owner. NE Howard and 7th.

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